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UNPRUNED TEA.

BY

H. R. COOPER.

Of late years tea has been left unpruned far more frequently than it used to be. On some gardens nearly half the area is being left unpruned annually.

This system has practical advantages.

ADVANTAGES CLAIMED.

1. Lengthening of plucking season.

From the unpruned tea, crop is obtained in the early months of the year (March, April, May) when pruned tea would be yielding little ; while tea pruned on two-year wood comes away later and will flush later in the season if weather continues favourable. The plucking season is thus extended at both ends. This, however, is not always such an advantage as it looks at first, since unpruned, as well as pruned, will be yielding most heavily in July, August and September ; and the pressure during these months is increased by the use of unpruned tea because it takes so much longer to pluck, since the average weight per shoot is less from unpruned than from pruned tea.

Unpruned tea, however, offers very real advantages to gardens on which the whole area cannot be plucked. In such a case a very fair crop may be obtained from unpruned tea plucked only from March to July when it can be abandoned. From good tea the cover will then be such that little or no jungle will grow, and therefore the tea will not suffer from lack of cultivation, while the tea being left to grow unplucked, will benefit enormously.

Meanwhile the tea which was pruned on two-year wood, can be allowed good growth in the early part of the year, to give a good crop starting late in the season. In this way a smaller crop will be made than if the whole area were plucked for the whole

year, but the loss of crop is counter-balanced by a gain in the health of the tea, because it is all underplucked; and over a series of years a bigger crop of better tea may be expected than if it were attempted to pluck the whole area with too small a labour force.

2. If plucked for the whole year better crops are obtained by the use of unpruned tea.

This is generally true at any rate for a time, but the gain is not so great as is often stated.

If the season is favourable, tea which has given an average of 10 mds. per acre pruned annually, may give 15 mds. if left unpruned. In the following season, however, after pruning on two-year-old wood, the crop will be less than the normal yield from pruned tea, and of course much less than it was from the previous year's unpruned.

In computing the gain from unpruned tea one frequently finds planters comparing the unpruned yield with the following year's yield from tea pruned on two-year wood.

For example the following yields may have been obtained—

Unpruned	Pruned
15 mds.	8 mds.

and the gain from unpruned tea is thus sometimes considered to be, in such a case, 7 mds. per annum.

It is, however, much more likely that the yields, if the tea had been pruned in both years, would have been, at least

Pruned	Pruned
10 mds.	10 mds.

The total in two years being thus 20 mds. as against 23 mds. in two years, using unpruned tea in one of the years. That is, the gain may be only about $1\frac{1}{2}$ mds. per annum instead of 7 mds. Even such a gain, of course, is very well worth having if the bushes are not deteriorating from the treatment.

3. Thicker wood is left to prune on after leaving bushes unpruned.

This is, of course, true. Other things being equal, thicker wood will naturally be grown in two years than in one year.

Thick wood, however, is only valuable because it indicates that the wood is in healthy, strong-growing condition. Since a cut on thick wood is less likely to heal than a cut on thinner wood, there is, however, certainly no advantage in cutting on thick unhealthy wood rather than on thinner healthy wood.

When thin twiggy wood is being grown on a poor bush, it would generally be better merely to clean out well, and to leave more growth before plucking after pruning, rather than to leave unpruned.

4. After leaving unpruned, the bush is easier to clean out.

The strong healthy shoots grow at the expense of the poor ones, which become *banjhi*, fail to grow, and often die. It is then a much easier matter to see which shoots should be taken and which left. On tea properly attended to annually there is seldom any difficulty in cleaning out moderately and well ; but on good tea which has become congested with a mass of small shoots, it is often of great advantage to leave it unpruned and then clean out.

5. The time and money spent on pruning are reduced.

The use of unpruned tea, then, offers advantages. It is necessary, however, to consider whether the disadvantages may not outweigh them.

Deterioration of tea from unfavourable seasons.—The tea crop generally has gone down since 1918. There are many reasons for this. The poor market in the slump year caused a deliberate curtailment of the crop in 1920, and 1921 ; while many gardens still suffer from decreased expenditure, and increased heavy pruning, immediately after the slump. Greater care in plucking has also tended towards a reduced crop. Still it is quite clear that large areas of tea are not now in condition to give the crops which they did in 1918, whatever the plucking. Large areas of tea have in fact deteriorated in the past few

years. This has been due to many factors. Decreased manuring, decreased cultivation, and over-plucking have contributed in many cases ; but there can be no doubt that we have latterly experienced a preponderance of seasons, which have been bad climatically, particularly in respect of droughty springs. 1919, 1922, 1923, and 1924 were all bad in this respect. 1925 was bad on account of low temperatures and failure of the rain later on, but although crops generally are down, the bushes are generally in better condition at the end of 1925, with its good spring, than at the end of 1924, after three successive dry springs.

Droughts, of course, are much more marked in the Surma Valley and in the Dooars than in Assam, and in both districts more tea is left unpruned than in Assam. In both districts it is difficult to escape the conclusion that tea which has been frequently left unpruned is in worse condition than tea which has been consistently pruned annually. Again and again the writer has been shown areas, records of which show that they have never recovered after being unpruned for two years out of four, or even sometimes after being unpruned only once. It is very noticeable, also, that gardens where tea has seldom or never been left unpruned do not show anything like so much deterioration in crop, or in appearance of the bushes, as gardens in the same district on which much tea has been left unpruned.

In the opinion of the writer, the general deterioration has been more marked wherever the tea has been unpruned.

Trial of Biennial Pruning.—From garden records it is impossible to obtain figures bearing on this point which can be regarded as very significant. Since no check plots are kept, it is impossible to guess accurately what the yield would have been had the pruning treatment of any particular block of tea been different. Records from the Experimental Station, however, yield figures of great interest. In this number of the "Quarterly Journal" the yields from the Jat Trial Clearance at Tocklai are given. This trial now comprises six plots of about half an acre each of six different varieties of tea. Of each

Table showing yields per acre from tea pruned annually and biennially respectively.

	1920.		1921.		1922.		1923.		1924.		1925.		AVERAGE ANNUAL YIELD OVER SIX YEARS.	
	Pruned on 1 yr. wood at 10".	Skiffed. wood at 10".	Pruned on 1 yr. wood at 14".	Pruned on 2 yr. wood at 10".	Pruned on 1 yr. wood at 16".	Skiffed. wood at 16".	Pruned on 1 yr. wood at 18".	Pruned on 2 yr. wood at 14".	Pruned on 1 yr. wood at 20".	Skiffed. wood at 22".	Pruned on 1 yr. wood at 16".	Bienni- ally pruned.	Annually pruned.	Bienni- ally pruned.
Kalline ...	5.13	11.34	9.74	8.17	12.50	10.95	12.72	9.90	12.08	14.86	11.44	7.92	10.60	10.62
China ...	4.02	10.88	7.13	8.84	9.12	8.70	8.58	8.38	6.70	11.78	5.71	6.88	6.88	9.43
Kharikatia ...	4.39	11.52	9.39	8.11	14.31	13.39	14.70	10.70	11.93	14.96	12.49	8.76	11.20	11.26
Singlo ...	4.32	9.91	8.21	7.27	12.21	10.90	11.77	9.65	10.78	13.60	10.10	9.15	9.56	10.08
Betjan ...	5.71	14.29	10.58	9.16	13.00	12.25	16.00	11.76	14.46	14.50	13.72	9.60	12.24	11.93
Panighat ...	4.57	11.77	8.82	7.65	12.42	10.77	11.99	10.19	12.32	14.50	13.46	10.60	10.59	10.91
Average—annually pruned ...	4.77		9.03		12.30	11.15	12.63		11.38		11.15		10.18	
Average—biennially pruned ...		11.63		8.29				10.76		14.03		8.82		10.66

plot half is pruned annually ; and the other half in alternate years only, being lightly "skiffed" in the intervening years.

On each plot the eastern end is on better soil than the western end, but as regards the pruning trial this unevenness is neutralised by using the east and west ends alternately for the same type of pruning, so that on the average one type of pruning does not get any advantage over the other in respect of soil.

Plan of Experimental Plots.

K A L J. Pruned annually.	I N E. Pruned in alternate years.	C H I Pruned in alternate years.	N A. Pruned annually.	K H A R I Pruned annually.	K A T I A. Pruned in alternate years.	S I N Pruned in alternate years.	G L O. Pruned annually.	B E T Pruned annually.	J A N. Pruned in alternate years.	P A N I Pruned in alternate years.	G H A T. Pruned annually.	N.
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The yields obtained are recorded in the table opposite.

During the six years of these experiments, then, we have made the following average crops from the same tea, treated identically except in respect of pruning.

Pruned annually ... 10.18 mds. per acre per annum.

Pruned every other year only ... 10.66 mds. per acre per annum.

The use of unpruned tea has resulted in an average gain of half a maund tea per acre per annum. The gain is less than what many people imagine would be made, but is still very well worth having. The system of leaving the tea unpruned in alternate years, also, has left the tea much lower. At the end of 1924 it was pruned at 16 ins. from the ground, whereas the annually pruned tea was pruned at 22 ins. from the ground. The annually pruned tea will, in the normal course, have to be cut back earlier than the biennially pruned tea will, because, unless special measures are adopted, it will earlier be too high to pluck.

So far, then, the system of pruning the tea only every other year has paid.

An examination of the records, however, shows that the gain has not always been steady.

	Total 1920 & 1921.	Total 1922 & 1923.	Total 1924 & 1925.
Annually pruned ...	13.80	24.93	22.53
Biennially pruned ...	19.92	21.91	22.85
Difference due to biennial pruning ...	gain 6.12	loss 3.02	gain 0.32

It is worth while to enquire why the system which gave such a big gain during 1920 and 1921, resulted in a loss during 1922 and 1923, and then again in 1924 and 1925 made no appreciable difference to the crop.

In 1920 the pruned tea started the season at 10 ins. from the ground, the skiffed at 27 ins. The bushes then were very different in size.

In 1922 there was a difference in height of only about 11 ins., instead of 17 ins., between pruned and skiffed tea. The difference in crop between pruned and skiffed tea would therefore be expected to be less in 1922 than in 1920. Still the difference in height was great, and, in addition, the skiffed tea was full of buds ready to give immediate crop, whereas the pruned tea had to grow shoots 11 ins. long before plucking commenced. Yet the skiffed tea averaged only 11.15 mds., while the pruned tea averaged 12.30 mds.

In 1924 there was a difference in height between pruned and skiffed tea of only 7 ins., yet the skiffed tea gave 2.65 mds. more than the pruned tea.

The loss in 1922, then, was abnormal. What were the conditions which were responsible for the loss?

Disadvantages of Unpruned Tea.—A plant takes in the whole of its carbonaceous food through its leaves. The whole of the remainder of its raw food material, taken in by the roots, is carried up to the leaves and there is combined with carbon to form prepared food-material which is carried from the leaves

all over the plant to feed it. If, then, leaves are left on the bush during the cold weather the bush continues to feed so long as it remains healthy. In that case, it is a great advantage to the bush to leave it unpruned in possession of all its leaves, so long as the stems are not left till they flower instead of continuing to produce leaf. Good indigenous tea has no great tendency to flower if left unpruned for one year.

The water which carried up the food material from the root to the leaf is got rid of by transpiration from the leaf. During normal growth the amount of water transpired by the leaves is equal to that taken in by the roots, less that retained to build up increased stem and leaf. The amount transpired depends mainly on the leaf area, but is increased by high temperature, and by dryness of the atmosphere. The amount taken in depends upon the root area, and is increased by high temperature, also by the moistness of the soil up to a certain optimum moisture.

Unpruned tea has a leaf area which was sufficient during the rains to dispose of all that the roots took in ; whenever the leaf area became insufficient for this purpose, the tea made up the deficiency by flushing. In a dry " cold weather," day temperatures are still high (particularly when drought persists into March and April) and the atmosphere is very dry, so that the transpiration is increased. On the other hand, the intake of water from parched soil becomes very small indeed. In such circumstances more water may be lost through the leaves than is regained from the soil. The result is drying of the leaf, and eventually of the stem. The bush is then in a very weak state, and may not recover when wet conditions set in. The bush suffers even if no disease attacks it, while the probability is that such a bush will suffer seriously from one or more of many pests and blights, and so be further weakened.

1920, with its almost continuously moist and cool cold weather, was exceptionally favourable to unpruned tea. In 1922, except for one fall of 1.8 ins. on 27th March, no rain sufficient

to reach even the surface roots fell till 25th April. During this time average maximum temperatures were—

January	...	73°F
February	...	78°F
March	...	82°F
April	...	85°F

1922 then was exceptionally unfavourable to unpruned tea, and indeed its suffering was obvious to the eye. Many bushes cast their leaves, and these suffered least. The remainder became yellow and flaccid. Attacks by red spider and by various leaf diseases were wide-spread. Many of the stems died right back, while many that were left alive were attacked by red-rust and other fungus diseases. In comparison the pruned tea, practically leafless during the drought, naturally fared much better.

In 1924 the season was not so unfavourable, but was not good, so that the gain on the unpruned tea was only just sufficient to offset the natural loss when the tea was cut back on two year wood in 1925.

To leave tea unpruned, then, is to gamble against the weather. A badly droughty spring means that less crop may be made than if the tea had been pruned ; and the loss does not finish there, but the tea may be so weakened that it does not recover for several seasons. Of the past few years, 1919, 1922, 1923 and 1924 were dry in the spring over wide areas of the tea districts, and tea left unpruned in those years was weakened in consequence more than it would have been had it been pruned.

The use of unpruned tea also introduces another possible cause for deterioration of the bush.

On well-managed estates when a bush is pruned it is usual, as far as labour-supply will allow, to cut out of the bush all diseased shoots and dead wood which may become diseased. If the sanitation of the bush is thus attended to every second year instead of every year, stem diseases naturally have a better chance of becoming established. After cutting on two-year wood, also, the new shoots, on the average, arise much further

from the pruning cut than on one-year wood. Even when the new shoot does arise near the cut, the cut is much less likely to heal than on one-year wood. After cutting on two-year wood therefore the bush is left with very much more dead wood than after cutting on one-year wood. Much of this dead wood becomes infected with fungus diseases, and if left for another two years these diseases will, in many cases, grow down and attack the living wood below the point at which the new shoot arises. In that case the removal of the old snag will not free the bush from the disease, which will carry on to hollow out the living stem.

On the Tocklai Clearance, which has just been discussed, *all* dead wood is cut out when the bushes are pruned. In spite of that all the cuts do not heal, and both annually and biennially pruned bushes are infected, to some extent, with wood-killing stem diseases. It is easily observed that the bushes which have been pruned only every other year contain many more diseased branches than the annually pruned bushes. This is particularly noticeable on the parts of poorer soil.

Precautions recommended in use of Unpruned Tea.—The practice of leaving tea unpruned is then attended by some degree of danger, and should not be used indiscriminately. It is a dangerous fallacy that to leave a bush unpruned “rests” it. On the contrary, it subjects it to a severe strain. It would be indeed surprising if one could “rest” a bush while, at the same time, obtaining greatly increased crop from it!

The following principles are believed to be of importance.

- (1) Having regard to the possibility that the following spring may be a dry one, only tea which is in good healthy condition should be subjected to the risk of being left unpruned.

Young tea, because it is vigorous and not in need of the stimulus of pruning to force it to continue vegetative growth, is particularly suited for being left unpruned. A young bush also requires plenty of leaf to feed it and thus grow strong roots and

branches. The introduction of one or two unpruned years, during the building up of a young bush, is very sound.

- (2) Unpruned tea should be manured in order to maintain its vigour. The mixture :—

2 mds. neutral sulphate of ammonia	} per acre
$\frac{3}{4}$ md. muriate of potash	

is a very good one for most soils. No phosphoric acid should generally be applied, since it would increase the tendency to over-ripening of the wood, and to early flowering in particular.

- (3) Unpruned tea should, if possible, be sprayed with lime-sulphur to keep off attacks by insect and fungus, particularly red spider and stem diseases.
- (4) When pruning on two-year wood after leaving unpruned, the pruning should be done early.

The tea should not be left to carry a large leaf area well into the next dry season.

Two year wood always comes away more slowly and irregularly than one year wood. Tea which has been unpruned for a season and then pruned late, will often in bad seasons produce the stunted growth popularly associated with green fly attack, when the same tea pruned early comes away normally.

Early pruning minimises these troubles.

- (5) Tea which has been unpruned and then pruned should not be left to carry the snags of two-year-old wood through two more seasons, as is normally the case when tea is left unpruned every other season.

The best time to remove these snags would be as soon as shoots have come well away after cutting on two-year wood. That is, assuming that the tea is pruned early in December, it might be gone over again in February or early March, and the

old wood cut off flush with the top-most healthy shoot. In that case the great majority of the pruning cuts, on a vigorous bush, would heal over, and one great cause of deterioration would be avoided.

Little harm results if these snags are left for one year. It is, however, impracticable, after a year's growth on a wide bush, to cut out the dead wood without first removing the top-hamper by pruning. Therefore unless the pruning can be gone over twice, as explained above, the rotation :—

First Year.	Second Year.	Third Year.	Fourth Year.	Fifth Year.	Sixth Year.
Unpruned.	Pruned.	Pruned.	Unpruned.	Pruned.	Pruned.

is much better than the rotation :—

First Year.	Second Year.	Third Year.	Fourth Year.
Unpruned.	Pruned.	Unpruned.	Pruned.

The first rotation however means that only one-third of the total area can be left unpruned.

Variations from absolutely Unpruned Tea.—Unless tea after pruning is plucked very accurately flat, the surface at the end of the year is more or less uneven, and is generally higher in the middle than at the sides. As such a bush is difficult to pluck, it is common to level off the surface by means of a very light pruning. This operation is known as “skiffing” or “skutching.”

This operation can, of course, be applied in various degrees of severity. It may be only sufficient to remove shoots which have run away, in order to level off the bush ; in which case the tea may be regarded as practically unpruned.

More often it is heavy enough to remove most of the green wood, so as to get below the “crows’ feet” formed by close plucking. This type of “skiffing” is still very light and it is unnecessary to leave any leaf before plucking hard and close. It probably gives a little less than would have been obtained from unpruned tea, but gives rather better (bigger) shoots, and is less liable to go “banjhi.”

Since the leaf area is somewhat reduced, tea which is "skiffed" is rather less liable to suffer from drying of the stems; but the pruning marks offer more easy points of attack for fungus diseases, so that, on the whole, "skiffed tea" suffers quite as badly as absolutely unpruned tea, in dry seasons.

Occasionally very-hard "skiffing" is seen, so that the pruning almost amounts to an ordinary "top prune" without any cleaning out. Tea need not be cleaned out every year, and unless the season is a very late one, a bigger crop will be obtained in the year when it is not cleaned out. Tea, which is skiffed very hard, suffers from drought little more than tea which is top-pruned without cleaning out; but it will also give very little, if any, more crop, while it still suffers from the evils of cutting on two-year wood in the following season.

Hard skiffing then offers little profit to offset its disadvantages, while the nearer the tea is to being absolutely unpruned, the greater will be the profit should the season prove favourable.

Effect on Quality.—Unpruned tea in the early part of the season gives very much better liquors than the sappy first flush from pruned tea. The early invoices are thus better from gardens with much unpruned tea. As the season advances the superiority in liquors from unpruned tea disappears, while a greater tendency to produce stalk begins to appear. Stalk from unpruned tea is probably due to its greater tendency to grow *banjhi* shoots on account of its great leaf area. It is probable that the production of stalk from unpruned tea might be greatly reduced by very careful plucking. That is, if complete *banjhi* shoots were never taken, but only the top soft leaf of a *banjhi* shoot as soon as it appears, then hard stalk would be largely avoided, and the tendency of the bush to go *banjhi* would be reduced. This however is very difficult, and in practice teas of rather less value are made, on the average, from unpruned than from pruned tea.

IMPORTANT POINTS IN TEA MANUFACTURE.

BY

P. H. CARPENTER AND C. R. HARLER.

Although it is realised that definite facts rather than general theories regarding tea manufacture are required, yet, since the leaf produced from no two areas is the same and conditions are different in every factory, it is impossible to lay down any hard and fast rules for the manufacture of tea. All that can be said is that under certain conditions, such and such a treatment will tend to accentuate this or that quality of a tea. There can be no standard process in tea making for conditions are always changing and each operation must be conducted with a view to making the best of existing conditions. Apart from this it is realised that the blending scheme at Home requires several definite kinds of tea and it seldom pays to alter the type of tea for which a garden has a name although it undoubtedly pays to improve the type.

The growing and plucking of the leaf is outside the scope of this paper but some indication as to what constitutes good leaf may be given. The best leaf is obtained from bushes having a long growth of old wood and a short growth of new wood and the cutting down of a garden generally brings about a falling off in quality over the next few years. The best tea comes from old, unpruned bushes and the poorest tea is from collar-pruned bushes. Darjeeling, a quality area, has large percentages of unpruned tea.

Plucking also influences quality for the closer the plucking the better the leaf. Many gardens in Assam pluck to the *janum* or "fish leaf" from the beginning of the season whilst in the Dooars and the Surma Valley longer plucking is employed in the early part of the season largely on account of climatic conditions. On the other hand, the stem near the *janum* is less succulent than that above a leaf and close plucking is liable to produce more stalky teas than is long plucking.

Both excessive shade and excessive sun can lower the quality of the leaf.

That good quality is made in the garden has become an axiom in the tea districts for in addition to the question of pruning, plucking and shade, factors within our control, there are other factors like the type of soil, *fat* of bush and climate, over which we can exercise little control, all influencing the leaf. It is recognised that gardens in some districts can more easily produce certain types of teas than gardens in other districts, *e.g.*, the Dooars can produce thickness of liquor and Assam can produce pungency, but the importance that needs to be acknowledged is that good leaf brought in from the garden is often spoilt owing to unsatisfactory conditions in the factory. It is noticeable that factories where good tea is made are invariably those in which great care is taken and attention paid to detail.

After the leaf is plucked it often necessarily remains in the basket for several hours before it reaches the leaf-house. It is known that the leaf in a tightly packed basket gets hot and temperatures as high as 140°F have been recorded in the centre of leaf baskets. This heating accelerates the withering process so that the leaf turns red. Whilst this in itself is not necessarily deleterious in that good tea can be made from red leaf, yet it is impossible to make good tea from a mixture of red leaf and fresh leaf, for the two represent different stages in the withering process. Red leaf can only be avoided by keeping the leaf cool and this is done by allowing plenty of air to get to the leaf. Although it is customary to bring in the leaf twice a day for withering, it is much better to send it in oftener if possible and a continuous supply of leaf throughout the day should be aimed at.

The leaf does not get hot on the top and at the sides of the basket although these positions are exposed to the heat of the sun. In fact leaf in the sun only gets slightly warm owing to the cooling effect of evaporation. The loss of moisture from the leaf in the basket constitutes the beginning of the wither but

with red leaf the process is carried much further without the loss of water. The chemical wither is well advanced in red leaf and often such leaf should be manufactured when it reaches the factory, for the full chemical wither is realised although the leaf is not physically ready. Red leaf should be separated from the fresh leaf as soon as it comes in from the garden.

It is of interest to observe that leaf tightly packed to the exclusion of air does not get hot. Such tight packing is impracticable and efforts must be employed in the direction of loose packing in order to keep the leaf cool.

THE WITHERING PROCESS.

The withering process is the most important in tea manufacture because no manipulation of the other processes in manufacture can make up for a poor wither.

The change taking place in the leaf as it withers is a complicated one, partly physical, partly chemical. The physical wither consists in the development of a flaccid or flabby state in the leaf owing to the collapse of the leaf cells, and the chemical wither denotes certain changes in the constituents of the cell sap. Both processes may go on separately, but in practice they go together.

It is sometimes thought that the main part of the withering is the obtaining of the leaf in a state fit for rolling. If this were all that were necessary withering could easily be carried on by passing leaf through some form of dryer. The process however is a chemical one and the physical change in the leaf is not an essential one to the making of black tea.

The original tea makers, the Chinese, rolled the leaf and twisted it and custom now demands a tea with a twist. But good black tea may be made from leaf which is still turgid and physically fresh.

Certain chemical changes must take place within the tea leaf in order that it may be made into black tea and the rapidity with which these changes take

The Chemical Wither.

place depends on the vitality of the leaf. As the vitality is lowered the processes are accelerated. The vitality may be reduced in several ways. The leaf may be poisoned, it may be heated or it may be partially dried, and all three treatments lower the vitality and hasten the chemical changes in the leaf.

Thus if leaf is placed in chloroform vapour it is poisoned and in ninety minutes the fresh green leaf has turned copper coloured although physically it is still fresh. This method is not practicable in the factory.

If the leaf is heated the chemical wither takes place rapidly in relation to the rise in temperature, provided that the latter does not rise above 155°F, at which temperature the enzymes are destroyed. In this case the leaf will not ferment and green tea results. Leaf has been heated in a saturated atmosphere so that no drying takes place, yet, if the temperature be high enough, and below that mentioned above, the leaf takes on the colour associated with the withered state in a short time. As the temperature becomes lower, heat, unaided by drying, takes longer to bring about the chemical wither, and we know that at about 85°F, the average Monsoon temperature, the leaf will not wither even in two or three days. This is a common experience in the rains when the atmosphere is saturated and no physical wither is possible. In lofts the wither is hastened by raising the temperature.

The usual means employed to lower the vitality of the leaf is to slightly dry it. When the leaf has become flaccid as the result of the collapse of the cells, then further drying is unnecessary and a certain time must be allowed to elapse for the chemical wither to take place, the time being dependent upon temperature and the amount of drying. The lower the temperature the longer will be the time required.

It is difficult to tell when the leaf is chemically ready, but a rough guide is given by the subsidiary veins of the leaf which turn from a bright green to a reddish brown when the leaf is ready. When this is noticed on the first leaf, the bud has

usually gone past this stage and practically the whole of it is reddish brown, whilst the second leaf will scarcely have changed at all. With coarser plucking the divergence between the chemical state of the various leaves is still greater. Herein lies one of the main difficulties in manufacturing good tea from coarse leaf.

The same amount of drying does not always produce the same results unless the time is altered to suit other conditions. Thus to-day the average temperature may be 85°F whilst tomorrow it may be ten degrees lower. Although on the cool day the leaf may possibly dry as quickly as on the warmer day yet the chemical wither will be more quickly realised at the higher temperature.

An important point to be noticed is that after the drying has produced a flabby leaf, further drying may retard the chemical withering. In open leaf houses conditions are often particularly difficult. When Monsoon conditions do not prevail, then the leaf sometimes dries without withering. During Monsoon conditions it often happens that the leaf has not dried sufficiently and the chemical wither has not proceeded far enough before the leaf has to be manufactured in order to make room for the incoming leaf. In using lofts care must be taken to stop the forced draught as soon as the leaf has sufficiently dried.

It is of the utmost importance that the leaf shall dry evenly.

The evenness of the wither depends on the kind of spreading which should be thin. Comparatively few factories have sufficient rack area to allow for ideal spreading so that one leaf shall not overlap another. This disadvantage is most noticeable in factories using fan lofts.

The best could be made of existing conditions by turning the leaf over on the racks till the drying has proceeded far enough. When this stage is reached the leaf may be collected together to minimise any further loss of water but an uneven rise of temperature must be guarded against. This treatment of the leaf is however practically impossible.

On the racks one pound of leaf should occupy about a square yard, more when it is wet and the atmosphere damp, less when the atmosphere is dry. With wire racks the spreading may be somewhat thicker than on hessian. This spreading is not ideal but it is thinner than that usually employed.

It is easy to tell when the leaf is physically ready, for when 4 lbs. leaf dry to 3 lbs. then the drying has gone far enough for rolling. Fresh leaf contains about 75 per cent. moisture so that the leaf in the state of dryness referred to, contains about 66 per cent. moisture.

Leaf is physically fit for rolling when it has become flaccid. Too quick drying, which may lower the moisture content of the leaf to 65 per cent., does not necessarily make it fit for rolling, because the chemical reactions may not have been realised. On the other hand, "red leaf" still containing a high percentage of moisture is often more flaccid than the leaf on top of the basket which has dried quickly in the sun.

Well withered leaf produces a black, well-twisted tea with a mature liquor whereas under-withered leaf gives a brownish flaky tea with a raw or bitter liquor. A strong broken tea such as is now demanded by the market requires a full chemical wither and a mechanical or physical wither on the light side. To produce teas such as this requires very careful control of the withering for it means that leaf must not be allowed to dry too far yet sufficient time must be given for the chemical wither to materialise. The chemical wither can of course take place without any drying but the time required is very long at ordinary temperatures.

Thus it is clear that any definite statement regarding the time leaf should be left on the racks is wholly futile, for the time must depend entirely on the atmospheric humidity or drying capacity of the air, and the temperature. This indicates how difficult it is to control the wither in open leaf houses.

When using withering lofts there are one or two points needing careful consideration. Warm air not
The Drying Capacity of Air. fully saturated with moisture is blown into the loft and then drawn across the leaf by fans at either or both ends of the loft. As this warm air passes over the leaf it picks up moisture and in time becomes saturated. It is obvious that as soon as this happens it ceases to be of use as a drying agent.

In order to avoid this, the air may be drawn through the loft more quickly but then there is a danger that the leaf on the racks near the air inlet will be over dried. For controlling the air supply different parts of the loft must be fed with dry air as, for instance, by means of air ducts, and the state of the air should be examined by means of the wet and dry bulb thermometers.

A few remarks may be written here about the drying capacity of hot air. It often happens that, on a wet day, saturated air goes into the tubes of the dryer but when the temperature is raised from say 85°F—the average ordinary air temperature—to 180°F or 200°F, although the moisture content or *absolute* humidity of the air remains the same, the *relative* humidity is lowered and the drying capacity is greatly enhanced. Again when the air leaves the dryer at 120°F, although then it not only contains its original moisture but also that picked up from the leaf during drying, it still has, by virtue of its temperature, a lower relative humidity, *i.e.*, a greater drying capacity, than when it entered the above. However before this air cools down to 85°F again, it will become saturated and deposit moisture.

The state of the air coming from the dryer naturally varies widely according to the speed of the air flow, the state of leaf being dried and so on. In one case it was observed that the exit gases from an Empire dryer showed wet and dry bulb readings of 100° and 120°F respectively. This represents a relative humidity of about 60 per cent. whereas the air had entered the furnace tubes with a relative humidity 87 per cent. represented by wet and dry readings of 79—82°F. When the

exit air in this particular case cooled to about 100°F it would become saturated.

The air going into the lofts is largely composed of hot air which has not been through a dryer and has a high drying capacity in spite of the fact that its temperature is lower than that of the exhaust gases from the dryer.

During the Monsoon it often happens that with an average temperature of about 85°F and a saturated atmosphere the leaf is liable to become sour before it has withered under natural conditions. If the chungs or racks are kept scrupulously clean and free of all leaf from the previous day it is possible to extend the withering period before the leaf goes sour.

For bad weather conditions where no withering lofts are available it is possible to improve the condition of leaf that has remained on the racks over night by passing it through a large automatic dryer like an Empire or an Endless Chain Pressure at a temperature of 110°F at a speed which discharges the leaf in 20—30 minutes.

ROLLING.

The rolling system in a factory is generally controlled by the number of rollers. It may be said that with a system consisting in two half-hour rolls and a final short one before firing one big roller will cope with about 1,000 maunds pucca tea in a season or four rollers can manage about 5,000 maunds. This figure only constitutes a very general guide and will not do for districts where the season is a short one and the crop crowded into four or five months. In estimating the machinery required for a factory the average heavy day should be considered and sufficient machinery put down to cope with such a day.

The system of rolling generally suggested runs on the following lines :—

10—30 minutes, light pressure

45 „ heavy „ with about—

10 mins. on 5 mins. off.

or 7, „ „ 3 „ „

10 „ final rolling after fermentation.

This system which includes *kutch*a sorting between the first and second roll is calculated to give tip. Many gardens roll hard the whole time and make broken teas which sell for their liquors. It is not suggested that these gardens should alter their rolling process since the teas produced meet a definite demand and fit in with the blending scheme at Home. But if at any time "tip" is needed, a light first roll will ensure that any tip present shall be visible. The final roll of 10 minutes is given for its physical effect only and in many cases no improvement has been recorded from the inclusion of this roll.

Hard rolling exposes red stalk and fibre but gives good liquors. Light rolling gives a better appearance but poorer liquors if the rolling is only continued for the same time as with the heavier pressure. The appearance of red stalk is also influenced by the wither and the fuller the physical wither the less will be the red stalk.

The speed of the roller is a factor worthy of attention. Early in the season, with only part of the machinery in use the tables often revolve at speeds in the neighbourhood of 80 revolutions per minute.

On one garden experiments were carried out in connection with roller speeds. In one case the roller made 58 revolutions per minute. The result was tippy B. O. P. of fine appearance amounting to 10 per cent. of the total and an O. P. rather poorly made, amounting to 20 per cent. When the roller worked at 78 revolutions a much smaller, less tippy B. O. P. was obtained amounting to 20 per cent. of the total leaf and a very well made O. P. amounting to 10 per cent. The liquors from the fast roll were better than those from the slow roll although it must be mentioned that the slow rolled tea had been submitted to 1,200 less revolutions of the roller during the rolling period of one hour than had the fast rolled tea.

In Ceylon the rollers revolve about 45 times a minute but the rolling period may be as long as three hours. Ceylon teas have

both appearance and liquors. If the slow method of rolling were to be adopted in North-East India then a longer roll would be necessary and many more rollers needed.

The temperature of the rolling room should receive attention for this influences the temperature of the leaf in the roller. The heat mechanically generated in the roller is very small and most of the rise in temperature here is due to the heat of fermentation. During the first roll the heat developed is small partly on account of the lightness of the pressure and partly because the fermentation has not well started. The heat developed in the second roll is greater but comparatively small compared with the effect of a warm room on the leaf temperature. Thus in a cool factory after 15 minutes' hard rolling in the second roll a rise of only 3°F was observed. In hot factories however temperatures as high as 105°F have been recorded during the second roll. The temperature of the rolling room should be kept at the same as the fermenting room and 82°F is suggested as a practical possibility for plains situated gardens.

The practice of making the rolling and fermenting room all one is good in that it ensures a cool rolling room although it is harder to control temperatures in a large space than in a small one and for this reason such an arrangement may not be ideal from the point of view of the fermenting room.

In some factories, air is blown into the rollers for cooling purposes. It is preferable to reduce the temperature by other means for this practice causes a certain amount of drying and oxidation of the leaf with the production of poor colours.

The flat type of *kutch*a sorter is preferable to the rotary type which is apt to get clogged with leaf at the corners where the battens are nailed to the mesh. This leaf becomes overfermented unless it is removed.

*Kutch*a Sort-
ing.

Unless the balls are all broken in the *kutch*a sorter or ball breaker then the fermentation will be uneven with resulting unevenness in the infusions.

Two meshes are sometimes used in the *kutch*a sorter the first two-thirds being of 4-mesh and the last third of 5 or 6-mesh. This arrangement is said to give a more even mixture of fine leaf than that given by a sorter containing the same mesh throughout.

THE FIELD EXPERIMENTS AT TOCKLAI.

BY

E. A. ANDREWS.

NO. 3. THE CLEARANCE.

The area which has come to be known as "the Clearance" is devoted to the cultivation of different varieties of plant, and contains the oldest tea on the Experimental Station. An account of the varieties of plant used, and of the procedure followed in establishing the plots, has already been published in the "Journal,"* and a further account of the behaviour of the plots to the end of the year 1920 was published in 1921.† Table I gives the total yields of the various plots from the years 1917 to 1924 inclusive.

* "The Tocklai Clearance," Quarterly Journal, Pt. IV, 1916, pp. 121-129.

† "Tocklai Clearance," Quarterly Journal, Pt. I, 1921, pp. 32-41.

TABLE I.

Yield in maunds of made Tea per acre.

Variety.	1917.	1918.	To end of 1918.	1919.	To end of 1919.	1920.	To end of 1920.	1921.	To end of 1921.	1922.	To end of 1922.	1923.	To end of 1923.	1924.	To end of 1924.
Manipuri	2.56	9.05	11.62	4.59	16.21	7.57	23.78	...	...	...	...	...	...	...	...
Burna	2.89	9.00	11.89	4.71	16.60	9.21	25.81	9.07	34.88	12.44	47.32	...	...	...	...
Kalline	2.53	9.34	11.87	4.38	16.25	8.23	24.48	8.95	33.43	11.72	45.15	11.31	56.46	13.47	69.93
China	2.05	7.67	9.72	4.26	13.98	7.45	21.43	7.98	29.41	8.91	38.32	8.48	46.80	9.24	56.04
Kharikhatia	2.62	7.25	10.57	3.66	14.23	7.95	22.18	8.75	30.93	13.85	44.78	12.70	57.48	13.44	70.92
Singlo	1.76	6.05	7.81	2.77	10.58	7.11	17.69	7.74	25.43	11.55	36.98	10.71	47.69	12.19	59.88
Betjan	...	5.64	5.64	4.35	9.99	10.00	19.99	9.87	29.86	12.82	42.48	13.88	56.36	14.48	70.84
Parichat	...	4.95	4.95	3.55	8.50	8.17	16.67	8.23	24.00	11.59	36.49	11.09	47.58	13.41	60.99

The Betjan and Panighat plots are, of course, one year younger from seed than the remainder, and had not yet caught up the others in total yield, though in yield per acre for 1920 they had both gone ahead of the Kharikhatia, Singlo and China. Since that year, as will be seen, the yield from these two plots has always been comparable with that from the other plots of the clearance, and they may therefore be considered to have caught up the remainder at the beginning of 1920, which is 5 years from seed and $4\frac{1}{2}$ years from planting. At the end of this year the Manipuri plot was removed to make way for the new Entomological laboratory, while at the end of 1922 the Bacteriological and Mycological laboratory similarly displaced most of the Burma plot. These variations have, therefore, dropped out of the experiment, but it is interesting to compare the order of yield of the remaining plots since 1920, which is as follows, the highest in order of yield being placed first.

1920	1921	1922	1923	1924
Betjan	Betjan	Kharikhatia	Betjan	Betjan
Kalline	Kalline	Betjan	Kharikhatia	Kalline
Panighat	Kharikhatia	Kalline	Kalline	Kharikhatia
Kharikhatia	Panighat	Panighat	Panighat	Panighat
China	China	Singlo	Singlo	Singlo
Singlo	Singlo	China	China	China

From this it will be seen that five varieties appear to have settled into a definite order as regards outturn, that order being

Betjan
Kalline
Panighat
Singlo
China

the first three having maintained this order for the last five years, the last two having maintained their order for the the last three years.

The displacement of the China plot to the bottom of the list is perhaps only what might have been expected, in view of the fact that it is both pruned and plucked in exactly the same manner as the indigenous varieties, whereas it is a matter of common experience that the best yields from China bushes are obtained when they are both pruned and plucked harder than is usual for indigenous tea, year by year the frames of the bushes are becoming higher and the sides of the China bushes are rapidly running to seed.

Another curious feature, however, is the behaviour of the Kharikatia plot, for, although this is a local seed, and is, moreover, a "once-removed" Singlo, which latter has behaved regularly, the Kharikatia plot has yielded very irregularly, being fourth on the list in 1920, third in 1921, first in 1922, second in 1923, and third in 1924.

At the beginning of 1920 it was decided to prune one half of each plot every year, and to leave the other half either unpruned or skiffed in alternate years, while following the same system of pruning in the years in which it was pruned. This system has been kept up, and the yields of leaf of the half-plots are given in Table II.

1914 Clearance :—

Table II.

JAT AND PRUNING TRIALS.

Previous Season's Pruning.	Yield in Maunds Pucca Tea per acre.										Total to date.
	1917 Collar.	1918 Unpruned.	1919 6"	1920 A. 10" B. Skiffed.	1921 A. 14" B. 10"	1922 A. 16" B. Skiffed.	1923 A. 18" B. 14"	1924 A. 20" B. Skiffed.			
Manipuri (Dark)	256	906	459	A. 462 B. 1052	974	1250	1272	1208	2083	4 years	2083
Burma (")	289	900	471	A. 541 B. 1284	880	1362	1676*	1258	2712		2712
Kalline (")	253	934	438	A. 513 B. 1134	974	1250	1272	1208	4497		4497
China (")	205	767	426	A. 402 B. 1088	884	870	838	1178	6209	7 years	6209
Kharikatis (Light)	262	795	366	A. 439 B. 1152	939	1431	1470	1193	6842		6842
Singlo (")	176	605	277	A. 432 B. 991	821	1221	1177	1078	7291		7291
Betjan (")	---	564	435	A. 571 B. 1429	1058	1300	1600	1445	5787	6 years	5787
Panigat (Dark)	---	495	355	A. 457 B. 1177	882	1242	1199	1450	6201		6201
Average all plots	240†	746	406	A. 477 B. 1163	903* 829*	1230† 1116†	1263† 1076	1480	6970		6970

* Calculated from yield of remaining
‡ of plot.

† plots.
‡ plots.

The effect of leaving the bushes unpruned every other year is reflected in the outturn to date, which is in every case higher than that from the corresponding half-plot which is pruned every year.

A curious phenomenon is observed, however, when the half-plots are arranged in order of yield for the last five years as was done above when the yields from the whole plots were being considered. The half-plots which are pruned annually arrange themselves as follows :—

1920	1921	1922	1923	1924
Betjan	Betjan	Kharikatia	Betjan	Betjan
Kalline	Kalline	Betjan	Kharikatia	Kalline
Panighat	Kharikatia	Kalline	Kalline	Kharikatia
Kharikatia	Panighat	Panighat	Panighat	Panighat
Singlo	Singlo	Singlo	Singlo	Singlo
China	China	China	China	China

while the half-plots pruned every other year fall into the following order :—

1920	1921	1922	1923	1924
Betjan	Betjan	Kharikatia	Betjan	Kharikatia
Panighat	China	Betjan	Kharikatia	Kalline
Kharikatia	Kalline	Kalline	Panighat	Betjan
Kalline	Kharikatia	Singlo	Kalline	Panighat
China	China	Panighat	Singlo	Singlo
Singlo	Singlo	China	China	China

It will immediately be seen that the annually pruned plots have maintained a fixed order of yield corresponding closely to the order of yield of the whole plots, while the half-plots pruned every other year have kept no definite order. The actual differences in yield, however, in the latter case, are not sufficient to affect the outturns of the whole plots materially, the behaviour of which may therefore be said to be determined by the behaviour of annually-pruned halves.

These results are of considerable interest, as indicating, first of all, that the various varieties appear to have adjusted

themselves to the surrounding conditions, and take up their definite positions in the scale of yield, by the fourth year after collar-pruning. The Kharikatia variety has proved to be an exception which cannot so far be explained. In the case of the unpruned half of this plot the results show that the tea has dropped back in the scale each year it has been pruned, and gone up in the scale again when left unpruned, but the variation has not been sufficient to affect the position of the whole plot in the scale.

A further point which is indicated is the apparent regularity of behaviour of tea pruned annually, as compared with tea left unpruned every other year, a fact which, if it be proved, will certainly emphasize the necessity for regular pruning of experimental plots, in order to obviate irregularities due to the behaviour of the bushes apart from the results of the treatment under test, and which may not be without its importance from the practical standpoint when control of outturn is under consideration.

METEOROLOGICAL OBSERVATIONS IN ASSAM, 1925.

BY

C. R. HARLER.

THE TEA CROP AND THE WEATHER.

It is impossible at present to forecast, even roughly, the tea crop in Assam. The trend of the crop curve for a period of two or three weeks ahead may be predicted with fair accuracy but such a prediction is of little value unless the period relates to the end of the season.

In considering the tea crop in Assam from the climatic point of view the year may be divided into four periods. The first is the cold weather, a period of low temperatures and consequent high relative humidities. The rain at this season is brought by breezes flowing in to fill up atmospheric depressions which pass from Persia across India at about Christmas time. Although depressions appear regularly the resulting rainfall is distributed unevenly. "Christmas rain" is useful in moistening the top soil but it has no lasting effect on the atmospheric humidity and is important in that it assists nurseries and young clearances rather than for its influence on the crop.

In February the temperature rises, humidity falls and the drought period may be said to have started. However plentiful may the cold weather rains have been a spell of hot, dry weather in March or April will wither the spring flush and give the season a bad start. To ensure a good start an early rise in humidity is necessary and this is only realised when the wind swings from the north to the south-west and moisture laden breezes bring the *Chota Barsat*. The early rains have an enormous influence on the tea crop.

The third period is that of the Monsoon which never fails in Assam. It varies in intensity but rain is always plentiful and humidity always sufficiently high.

The last period of the year is that of the retreat of the Monsoon when the temperature and humidity fall sharply and

the period between flushes is lengthened till the leaf finally gets so tough that it cannot be manufactured satisfactorily. A good back-end is one in which the humidity drops slowly. Plentiful late rain does not necessarily mean a good finish for any factor which lowers night temperatures at the end of the season necessarily slows up the flush.

It will be seen then that the early rains and the retreat of the Monsoon are the deciding factors in tea crop production in North-East India and at present neither of these events can be predicted far ahead with certainty.

The chief factor responsible for the early rains is the moving north of the thermal equator. This phenomenon may be explained as follows. Two sets of winds, the north-east trade and the south-west trade, meet about the geographical equator producing a belt of calms where rain is plentiful. These winds originate from the great heating of the equatorial region and it will be understood that as the year advances and the sun moves north to the Tropic of Cancer (Calcutta stands in this latitude) the rain belt will tend to follow the heat belt or thermal equator. The advance of the early rain may be hastened or delayed by conditions either in India or south of the equator and it is only as detailed observations extend over a wide field that the coming of the early rains may be predicted.

With the advance of the Monsoon there is a general airflow of moist, warm air from the south-west and with the retreat of the Monsoon a flow of dry cool air from the north-east fortifying the north-east trade wind which the south-west Monsoon had previously extinguished. The cessation of the pressure from the south-west, the short period of calm and then the flow from the north-east will also be periods liable to variation with conditions all round the Indian Ocean. In Assam there are generally signs in August and September indicating what the end of the season will be. It is doubtful, however, whether we shall ever be able to foretell what the end of the Monsoon will be early on in the season.

During the 1925 season the early rains and the absence of a dry spell in May pointed to a good June and July which were duly realised and by the end of July the crop was well ahead. Now there is a general feeling in the tea planting districts that a good start to the season presages a poor close and the short autumn crop in 1925 was not unexpected. This observation comes from experience and on examining meteorological records it is seen that such a conclusion is not based on the possibility that good early rains (*i.e.*, high humidities early in the season) necessitate poor late ones or an early withdrawal of the warm, moist breezes constituting the south-west Monsoon. If this were so it would signify that an average rainfall were well within the range of what might be expected and that big falls early on necessitated poor ones later. This is not so. At Tocklai with an average rainfall of 82 inches the past eight years has shown values as divergent as 66 and 101 inches. Further down the valley the variation is greater and at Sylee, in the Dooars, with an average of 164 inches the precipitation in the past eight years has varied between 113 and 204 inches. Hence because the early rains are good it cannot be argued that at the end of the season there will be a rain shortage.

One possible explanation of the fact that good early tea crops are generally followed by normal or poor late ones is that the soil under a certain treatment has a certain crop capacity much beyond which the bush will not go.

Throughout the tea areas of North-East India the soil and bush capacity have generally increased during the past twenty-five years from about 400 lbs. to 700 lbs. made tea per acre. The general increase of the average crop over four-year intervals is a steady one but the crop of individual years is irregular. The general crop increase is due to improved methods, more efficient manuring and better work generally but the annual variation is due primarily to the weather. Any district subject to a wide variation in climate will also be subject to a similar variation in crop. On this account the crop fluctuates much

more in lower Assam than in Dibrugarh and still more in the Dooars than in any part of Assam.

THE 1925 SEASON IN ASSAM.

The 1925 season started well but closed early. In January over three inches of rain fell at Tocklai constituting a record since observations have been made here. Very little rain fell in February but the skies were cloudy and temperatures generally low thus reducing the drought effect. A cloudy day may almost be reckoned as a day deducted from the drought period. Rain came early in March with a sharp rise in humidity which remained high till the Monsoon arrived.

The Monsoon broke on about 20th June and its advance was marked by a change in the wind direction and a general rise in humidity.

In August the nights became cool and in September the bushes took on the cold weather appearance associated with an early close. Low humidities were registered along with low temperatures and these two factors had much to do with the early close.

The table below shows the average maximum and minimum temperatures recorded during the past seven years at Tocklai from the height of the season in August till the end of the year.

*Table showing Maximum and Minimum Temperatures
at Tocklai.*

Season.	August.		September.		October.		November.		December.	
	Max. °F	Min. °F	Max. °F	Min. °F	Max. °F	Min. °F	Max. °F	Min. °F	Max. °F	Min. °F
1919 ...	91	78	85	75	83	72	78	64	73	54
1920 ...	89	77	89	76	85	70	81	59	75	52
1921 ...	89	77	88	75	82	71	80	60	72	53
1922 ...	89	77	89	76	85	68	80	59	73	50
1923 ...	88	80	87	76	84	69	80	60	74	50
1924 ...	90	77	88	75	87	73	77	62	73	54
1925 ...	89	75	87	72	83	66	79	53	73	43

It will be seen that the two years with stand out good late flushes, 1919 and 1924, both showed high minimum temperatures in October. Both these seasons happened to start poorly. In 1925 the start was exceptionally good but low minimum temperatures from August onwards did much to bring about the early close.

The end of the year 1925 was exceptionally cold. The lowest temperature previously recorded at Tocklai was 40°F but during the year under consideration 39°F was recorded twice, 38°F once and 37.8°F once. It will be interesting to observe whether these low temperatures will have any effect on pests and blights during the ensuing season.

Below is a table showing the monthly rainfall in 1925 together with the average over the past seven years.

Table showing Rainfall at Tocklai.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Average (7 yrs.)	0.51	1.52	3.15	8.85	8.89	13.28	16.12	10.42	10.49	4.57	0.79	0.08	81.65
1925	3.15	0.80	3.56	7.03	15.11	9.50	21.36	9.79	10.79	4.33	0.83	nil	86.29

AIR MOVEMENT.

The windage or air movement is measured daily at Tocklai and the general wind direction noted. The 1925 season, like the previous one, was remarkable on account of the absence of severe wind storms in the spring. The anemometer or wind recorder is placed on a structure 20 feet above the ground and although the wind direction at this height changes throughout the day the general drift is from the north in the cold weather and from the south-west in the Monsoon. During 1925 the Monsoon was a weak one and the steady south-west breeze was never established for long. The air movement is important in the spring before the early rains in that it is the factor which largely decides the severity of the drought. A steady, dry breeze may wilt a bush in a very short time.

The table below shows the average daily windage in miles during each month at Tocklai from June 1924 when the anemometer was installed till the end of 1925. The values denote the average total daily air movement.

Table showing Wind at Tocklai.

	Jan.	Feb.	Mar.	Apl.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1924	.....	.....	.....	.....	.....	40	40	37	31	27	24	13
1925	42	37	55	74	30	44	46	45	46	26	16	16

The increase in air movement till April, our windy month, the lull before the Monsoon and the steady breeze during the Monsoon are well marked in 1925. The high value recorded in January is due to one windy day, the 14th, when 404 miles were registered followed by a fall of hail, an occurrence rare for Jorhat. The hail stones measured from $\frac{3}{4}$ ths. to $\frac{1}{2}$ inch in diameter. Without this day the average windage in January would have been about 30 miles. The most windy day of the year occurred on 28th. April when 490 miles were recorded.

The spores of blister blight are wind borne and if other conditions are favoured there is probably a direct correlation between wind and the spread of the blight.

At Tocklai observations made near the tea have shown little else than grey blight as an air-borne fungus attacking tea.

SUNSHINE.

The table shows the average monthly sunshine in hours recorded over the past seven years together with the monthly values for 1925.

Table showing Sunshine at Tocklai.

	Jan.	Feb.	Mar.	Apl.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Average (7 yrs.)	5.4	5.8	5.8	5.0	4.8	4.0	3.9	4.3	4.0	5.9	5.4	5.1
1925	4.4	5.6	5.9	3.5	3.3	5.2	5.1	4.4	3.4	5.7	5.7	5.4

There is little to note except the shortage of sunshine in April and May. Partly on this account, nurseries were good during the 1925 season.

The subject of the effect of sunshine is a complicated one and our figures do not carry much significance since we only record sunshine above a certain intensity. In South Sylhet the southern slopes of the *teelas* suffer much from the sun partly no doubt due to the drying out of the soil and partly to the actual sun intensity. The slopes suffer most in March, April and May. At the period of the Spring Equinox the sun at noon stands at an angle of about 25° in Sylhet (Sylhet is in latitude about 25°N and at the Spring Equinox, 21st March, the sun is overhead at noon at the equator). The heat of the sun is greatest at about one o'clock after it has passed the zenith and when it stands at about 30° in the spring months in Sylhet. Thus a slope of 30° will receive the sun rays at a maximum intensity and a slope greater or less than this will receive sunshine of a lesser intensity during the critical months of the dry season.

In Darjeeling the southern slopes also suffer in the lower altitudes but above 4,000 feet they are usually better than the northern ones, other conditions regarding soil, and so on, being the same.

The maximum sun temperature is measured daily at Tocklai by means of a registering thermometer with a blackened bulb, sealed in an evacuated tube. The table below shows the monthly average sun temperature together with the monthly average maximum air temperature. The difference between the two values may be taken as some measure of the solar radiation.

Table showing Sun Temperature at Tocklai in 1925.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F
Air max. temp.	68	74	81	81	82	90	90	89	87	83	79	72
Sun temp.	108	111	121	122	126	135	138	136	138	123	116	105

High sun temperatures are usual in countries of low latitudes where the sun is high-pitched. In the Everest expedition of 1924 air temperatures of 29°F were recorded at noon on the North Col of Mount Everest, altitude 23,000 feet, latitude 28°N, whilst the sun temperature at the same time was 105°F.

THE SOIL CONDITION.

The soil moisture, soil temperature at 1 foot and 3 feet and ground temperature are taken daily at Tocklai.

The soil moisture is an important figure in that with the atmospheric humidity it gives a measure of the severity of the drought. The loss of soil moisture from surface evaporation may be reduced to a negligible quantity by mulching. However, a bush carrying full foliage is able to dry out a soil in a very short time if the atmospheric humidity is low and conducive to heavy transpiration of moisture from the leaves. In districts subject to drought unpruned tea is thus a menace for when the spring flush appears, as it does whether the drought is over or not, there is often insufficient moisture in the soil to keep it going because the old leaves on the bush have already removed most of it.

The average weekly soil moisture is shown on the weather chart. Only during one week in 1925, the fourth week in March, was the soil moisture at all low. At Tocklai the optimum water content may be taken as about 15 per cent.

The soil temperature followed fairly closely the values shown in previous years. Observations have been made since May 1922 and although no practical results have as yet been achieved the use of such figures may well appear later on. Thus it has been experimentally shown that certain soil-borne diseases, including tomato wilt, flax wilt and tobacco root rot, are greatly influenced by environmental factors, and that the destruction wrought by these diseases may vary from a negligible quantity to the total crop by the variation of one factor only, namely soil temperature. It has also been shown that flax and

tomato wilt are favoured by high soil temperatures and tobacco root rot by low soil temperatures.

The possibility of alterations in soil temperatures on a tea garden is immense. The soil on an unpruned section will be much cooler than that on a collar pruned one and the coming and going of root disease after collar pruning is no doubt influenced by this temperature factor.

The table below shows the average monthly soil temperature at 1 foot and 3 feet of a grassed plot at Tocklai.

Table showing Soil Temperatures at Tocklai in 1925.

	Jan.	Feb.	Mar.	Apl.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F
1 foot	64	67	72	73	79	85	88	88	85	84	73	64
3 feet	67	68	72	76	78	84	86	86	85	81	76	68

It may be generally said that the coldest period in Assam comes in about the first week in January and this is reflected in the soil temperature at 3 feet which lags behind the air temperature and touches its lowest about the third week in January, after which it steadily rises.

The terrestrial radiation or ground temperature is taken daily and is measured by means of a minimum registering thermometer placed six inches above the ground. This value together with the ordinary minimum temperature, taken in the standard white, louvred box at a height of 3 feet from the ground, is given below.

Table showing Ground Temperature at Tocklai in 1925.

	Jan.	Feb.	Mar.	Apl.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F
Min. Air Temp.	51	54	59	66	69	73	74	75	72	66	53	43
Ground Temp.	54	49	58	71	69	75	78	77	74	65	53	43

The months when the average minimum ground temperature is lower or about the same as that of the minimum temperature of the air are those during which dew is deposited.

THE WEATHER CHART FOR 1925.

The weather chart for 1925 is drawn on the same lines as in the previous few years. The top curve shows the state of the soil by means of the soil moisture. The curves at the bottom include the maximum and minimum temperatures, the absolute humidity or vapour tension of the atmosphere and the rainfall. The curves in the centre of the chart show the weekly crop in pounds green leaf obtained from the Tocklai Clearance, an area of $2\frac{1}{2}$ acres. One object of our study of meteorological conditions is to obtain the degree of correlation between the atmospheric and soil condition and the crop.

The area used for correlation consists of five half acre block half of which are pruned annually and half biennially. During 1925 the annually pruned bushes were cut to 22 inches and the biennially to 16 inches. A full description of these plots is given in another part of this journal.

The top black crop curve gives the total weekly crop and the two red curves give the crop from the annually and biennially pruned sections which go to make the total crop. Unfortunately labour troubles in July prevented the area from being plucked for 14 days. At the end of this time the bushes were plucked back to the old level, in many cases six and seven leaves being taken. On this account the significance of the subsequent pluckings is to a certain extent vitiated and any detailed observations correlating flushes and weather must be open to doubt.

At Tocklai the bushes are plucked every seven days to the *janum* or "fish leaf" and the crop curve obtained is the natural one, marking the true capacity of the bush. Experience over the past few years has shown that September is normally the best cropping month whether the tea is pruned or unpruned.

On some gardens the general form of the monthly crop curve has been recently changing so that the best month is August. It is often thought that this change is due to the large percentage of unpruned tea on a garden but the unpruned tea at Tocklai yields best in September the same as pruned tea. The reason why unpruned tea on the average garden ceases to yield in August or September is that the later flushes are composed of leaf so small that it hardly pays to gather.

A FEW NOTES ON BLISTER BLIGHT.

During the dry seasons experienced in the past few years Blister blight has done very little damage in Assam but it must not be thought that this disease has lost its virulence. After the wet seasons some years ago when blister was severe planters took great care to eliminate harbouring places such as old nurseries, stray bushes in the jungle, etc., and on many of the gardens which used to be badly attacked each year the disease was eradicated. In consequence of the comparative freedom from the disease resulting partly from the dryness of the early part of the season in recent years and partly to the efforts of the planters to eliminate harbouring places there is a growing tendency to believe that the seriousness of the disease was overrated.

During this cold weather a considerable amount of Blister blight has been noticed on Assam gardens and unless steps are taken immediately to keep it in check there is a prospect of a severe attack should conditions prove favourable. It is strongly recommended that a careful search for the blister be made on all gardens in the districts which are subject to it. Tea growing in damp shady places close to the jungle should receive particular attention.

Wherever the blight is found the blistered leaves should be plucked off and buried on the spot. The disease dies very rapidly and it is probably unnecessary to bury the leaves. It is however just as well to be on the safe side. The carrying off of the diseased leaves for burning or burial often tends to distribute the disease further.

The examination of the bush and removal of diseased leaves should be repeated, 10—11 days later.

Any places where the disease has been found in the second examination should be carefully noted and examined a third time 10 or 11 days later.

If any disease is found on the third examination the area concerned should be thoroughly sprayed twice at an interval of 10—11 days with a fungicide such as Lime-sulphur solution, see "Quarterly Journal," Part III, 1925.

The jungle in the neighbourhood of the diseased bushes should also be carefully searched for tea plants and all such should be dug out.

If the above treatment is done carefully there is no need to fear a severe attack except in places where the tea is near to a neighbour's garden.

When a garden is severely attacked by *Blister blight* in the rainy season it is useless to attempt to keep the disease in check. In this case it is desirable to concentrate on protecting the young tea or cut back tea from attack. To do this it is necessary to spray it with a fungicide at intervals of 10 days until the weather removes the blight from the rest of the tea or the young growth has hardened.

It is hardly necessary to point out that *Blister blight* on young succulent growth is very serious and often kills it right back to the red wood.

In Assam where gardens are more or less isolated the disease can be eradicated in the cold weather from individual gardens but in Darjeeling where gardens are very close together it is very difficult in the absence of whole-hearted co-operation.

It is interesting to note that during the past few months the careful examination of over 60,000 tea seeds has failed to reveal a single specimen of fungi belonging to the Basidiomycetes the order in which *Exobasidium vexans* is included. As a number of the samples came from gardens known to be infected with *Blister blight*, it would appear that the chances of this blight being carried in tea seed are very small.

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THE TREATMENT OF ROOT DISEASES.

BY

A. C. TUNSTALL.

Few planters realise even yet the amount of damage done by root diseases. It can be safely said that not one tea garden is free from some form of root disease. This is not surprising when we consider the amount of root disease producing fungi present in the jungle. Most of the North-East Indian tea gardens were planted out on cleared jungle land. It is quite impossible to remove all the dead wood from the soil of newly opened forest land and sooner or later the fungus diseases present in the dead wood attack some of the tea bushes. In the case of some diseases the power of infection may be retained for many years on dead wood. For instance, at Tocklai an outbreak of brown root disease (*Hymenochaete noxia*=*Fomes lamaoensis*) was traced to a piece of Nahor (*Mesua ferrea*) root which must have been buried in the soil 4 feet deep for at least fourteen years.

It is obvious therefore that outbreaks of root disease must be expected and a constant watch must be maintained to check such outbreaks as soon as they occur.

It has often been suggested that only certain jungle trees are attacked by the fungi which cause root disease in tea and if a list of these trees were prepared special care could be taken to remove their roots from new clearances before planting. This, at first sight, appears to be a very reasonable suggestion but when the attempt was made to work it out in practice it was found impracticable. Although certain trees are more liable to be attacked, when alive, than others: the others are just as liable to attack when dead. It is therefore necessary to dig out all the tree roots if root disease is to be avoided. This is a practical impossibility so that, although much can be done to avoid it by careful clearing, some root disease is bound to occur sooner or

later. The more dead wood is left in a new clearance the more root disease is likely to attack it. Even sawn timber, such as the planks of bridges, fence posts, etc., are liable to start root disease.

The neglect of a single outbreak of root disease may in time result in the loss of hundreds of bushes and it is of the utmost importance to act promptly.

The first thing to do is to remove the dead bush. If only one bush has died special care should be taken at the time of removal to trace out its various roots. In many cases only one lateral is badly diseased and if this is traced it frequently happens that the centre of infection is found and may be removed. If all the diseased roots are carefully traced out some of them will often be found to be in contact with those of neighbouring bushes. All the bushes whose roots are found to be in contact with diseased ones should be dug out also. All the little pieces of root should be placed in a basket as they are removed from the soil. No wood should be allowed to remain in the soil. This wood should be promptly burned. If this work is done carefully the outbreak will be satisfactorily checked and there is no need for further treatment. The vacancies may be filled in whenever convenient.

It is frequently suggested that some chemical treatment should be applied to the soil. This is in most cases unnecessary and in any case no chemical applications avoid the necessity of removing the dead wood. That must be done and the success of root disease treatment depends on the thoroughness with which it is done. It is fairly obvious that no chemicals applied to the soil are likely to kill a fungus present inside wood. It may under exceptionally favourable conditions kill the fungus on the surface of the wood. The root disease fungi are mostly inside wood, not free in the soil, and in consequence it is much better to carry out the removal of the wood thoroughly than to rely on the application of a patent medicine to the soil. If the soil is in an unsatisfactory condition manures suitable to the soil requirements should be applied. Some root diseases only thrive

on plants growing in soil which is insufficiently aerated. Lime is often useful in these cases because it tends to flocculate the soil and thus helps to improve drainage. It is also supposed to aid bacteria in the breaking down of woody matter. In a few cases, *e.g.*, *Rosellinia Sp.*, it is known to have a direct effect on the fungi concerned. Its efficiency in this respect has been overated in the past. In a number of instances its application has certainly checked some root diseases but very frequently its effect has not been noticeable. In this connection it is interesting to note that some planters hold the curious idea that lime should be sprinkled on the bottoms of trenches cut to isolate diseased roots. This lime would do no harm but it is difficult to see what good it could possibly do. The isolation of the roots of a diseased bush from those of its neighbours by means of a trench cut deep enough is very useful in cases where the dead bushes cannot be removed at once but it generally involves as much labour as the removal of the dead bush. It is only recommended therefore in the case of comparatively large areas of dead bushes. It should then be dug so as to enclose two complete lines of apparently healthy bushes and when time permits all the bushes within the trench, dead, dying and apparently healthy ones should be dug right out every bit of wood being removed from the soil and burned. It is generally more satisfactory to take out a complete rectangle as it is easier to supervise replanting.

TO SUMMARISE—The only satisfactory way to deal with root disease is the complete removal of the diseased material. No chemical treatment will ever obviate this necessity. Promptness in the removal of the diseased bushes and all dead wood in their vicinity is essential.

CUT-BACK TEA.

BY

H. R. COOPER.

Any form of heavy or medium pruning must be followed by loss of crop for at least several years. Unless, therefore, the bush after this period is permanently and greatly improved by the cutting back, the operation has only entailed increased expenditure and decreased returns.

In a large number of cases in practice, cutting back, so far from having effected any improvement in the bushes, has rendered them much worse than they were before. Unless it is remarkably vigorous any stem cut when an inch or more in thickness throws a new shoot from some distance below the cut. The wood above the new shoot dies, leaving a snag which very soon becomes diseased and starts the rotting of the remainder of the stem. Even when the snag is removed within a year or two after cutting, the cut through dry wood will not callus and disease may enter through the wound.

Collar pruning is not necessarily a safeguard against introduction of disease after cutting back. Collar pruning means a cut through the thickest and oldest part of the bush, where it is most difficult for the wound to heal over, and if a disease is introduced at the collar it cannot afterwards be removed by pruning.

Cutting back is too often performed as a matter of routine, or worse, as the only method of restoring a weak bush to health. Many areas of tea which are considered to require cutting back on account of weakness or decreasing yield are really in need of nursing and feeding because they are suffering from the results of their last attack of cutting back.

Tea is often cut down because it is weak, and nothing done to remove the cause of the weakness. As soon as the production of dark green vigorous shoots following the stimulus of

cutting has ceased, the original cause of weakness again asserts itself with increased force on a bush further weakened by cutting. In bad cases, the stimulus of cutting fails to produce even the first vigorous shoots. The worst tea one sees is usually tea which, being originally poor, has been further weakened by cutting, and has soon afterwards been cut down again.

Cutting down, by itself can only effect any improvement either because disease of the stems is thus removed, or because good growth is given after the cutting. In the latter and more general case, greater improvement, with less loss of crop, could have been produced by allowing good growth by sparing plucking, without cutting down, particularly if cultivation and manuring were improved also.

Cutting down, then, has no virtue in itself and introduces causes of danger to the bush. It should therefore be avoided when possible. The cause of mere weakness or of decreasing yield should be traced, and the cause removed; while the presence of diseased branches should be treated by the clean removal of the diseased branches only, while, again, the conditions which render the bush susceptible to the particular disease should also be improved.

There are however cases when one step towards the simplest method of restoring a section to full yield is some degree of heavy pruning. Such cases are most commonly met with on old tea, generally because the removal of single branches as they became diseased, and the clean removal of snags which introduce disease, have not been properly dealt with during the ordinary routine of pruning, while preventive measures such as spraying and correct manuring have probably been neglected, also.

CONSIDERATIONS REGARDING SEVERITY OF CUTTING BACK.

Any pruning which still leaves diseased wood in the bushes can only effect a temporary improvement in vigour at best. It is for this reason that any kind of medium pruning is in such disfavour with a very large number of planters. The school

which favours making a clean sweep of everything by cutting right down to the ground is strongest in Upper Assam where not only is the climate relatively very favourable to this operation, but bushes thought to require it are generally in better condition than, for example, on a hot droughty exposed teela in the Surma Valley. Yet even in Upper Assam 10 per cent. of good bushes may be expected to be lost after collar-pruning, while the loss is very often 20 per cent., and in bad seasons 40 per cent. of deaths is not uncommon. On account of this possible heavy loss a very large number of men condemn collar-pruning altogether. Between these two extremes the truth lies.

Since a bush is entirely dependent on its leaves to provide food, a bush deprived of its leaves can only throw fresh shoots by drawing upon ready-formed reserve food material in its stems and roots. Until fresh leaves are formed the whole life-cycle ceases. The young fine rootlets of a collar-pruned bush die and have to be re-grown after a fresh food supply is established from new leaves grown out of reserves. Such reserves are naturally greater in a medium-pruned than in a collar-pruned bush, and in consequence the number of deaths after medium pruning is very small indeed, both because a larger amount of stem means a larger amount of reserve food in the bush, and because from the thinner wood left, new shoots will more readily arise.

The more good clean wood which can be left on a bush, therefore, the better, but no branches carrying disease must be left, otherwise disease will spread to the sound parts of the bush. Neither is the presence of hollowed, knotted or otherwise damaged wood desirable in a bush which is to be renovated. To remove everything undesirable of this nature often does mean that the bush must be practically collar-pruned. There are however cases where only the top has become attacked by diseases, or where it is desired simply to reduce the height of a sound bush to allow more convenient plucking. In such cases it is often possible to leave a good frame composed of sound branches, by cutting the bush across at a convenient height and removing only a little unsound wood below that height.

When cutting back the reduction of the height of the bush is always a consideration, and for that reason it is hardly sound to make the cut any higher than about 18 inches or the bush will too soon be over-high again. On many bushes a cut at 18 inches would leave little more than a single stump which is most undesirable. It is not worth while to medium prune unless something of a frame is left, and for this reason, also, the only method of cutting back a bush may be practically to collar-prune it.

In practice then, either because there is no frame sufficiently near the ground or because the frame is composed almost entirely of diseased branches, the only sound method of cutting back a section is often very nearly to collar-prune most of the bushes. It is urged however that whenever there is a chance of preserving a good sound frame, it should not be neglected.

To cut a bush to the collar leaving nothing, when some good clean branches might have been left, is a serious error, because the percentage of deaths is unnecessarily raised. Particularly is this so when fine young shoots near the collar might have been left, so that one could get the advantage of removing the whole of the old wood while leaving shoots to ensure that the plants will live, and come away much more quickly and strongly than if no shoots had been left. If there are no such shoots then older thicker wood may often be left, so long as it is sound. From such branches shoots will arise much quicker than from the stump, even if the branch is so cut down that no leaf remains on it, but it is of course an advantage to leave leaf if possible.

When such "Kickers" are left there is a tendency for them to become attacked by red spider and other diseases. It is therefore sound to cut these away, or down to good wood, after they have done their work, that is when new shoots have arisen from the stump. In leaving "Kickers," also, care should be taken that if they are strong then kickers should be left on each side of a stump, or a one-sided bush may be grown, and that side of the stump from which no shoots arise will rot, and

eventually so will the whole bush. If only one strong kicker is left, it must be cut away very early.

Both opposite opinions (1) that tea should never be collar-pruned, and (2) that collar-pruning is the only satisfactory method of cutting back, contain germs of truth, but both err in going to extremes. Every individual bush should be treated on its merits, but in practice it is necessary to give a fairly simple order.

If it is decided that there are frames worth saving, then an order may be given to cut down to the particular height which suits the average bush best, with the proviso that all diseased branches must be removed cleanly, while some few bushes may have to be collar-pruned.

If it is decided that it is necessary to cut right down, then that order may be qualified by ordering that young shoots or good branches from near the collar must be left. Both jobs require good supervision, but it is remarkable how soon good coolies grasp the principles, and apply them.

In addition to the points already referred to a few others may be briefly mentioned.

LEAVING SHOOTS.

As far as possible one should aim at the avoidance of snags. If a branch can be removed flush with a shoot, however poor the shoot may be, the remaining wood is preserved from death by the flow of sap induced by the presence of the shoot ; and if the shoot or a new one arising just under it, can be induced to grow with sufficient vigour, then the cut (if made cleanly) will callus over, and leave no wound to be infected. When a cut at a certain height is ordered, it is always worth while to make the cut a little higher or a little lower if by so doing a shoot can be left.

KNOTS.

If there is a knot in the branch, a new shoot often arises from the knot nearest to the cut. For this reason many planters are in favour of making the cuts through knots, and in that case

a large number of new shoots do arise from the top of the cut shoot. The knot however is a very hard thick piece of wood, and a clean cut through it is very difficult to make. A cut through a knot also is difficult to heal even with a shoot to help it, neither is a shoot from a cut knot usually as good as a shoot from straight wood or even as a shoot from the next lower knot. It is probably better therefore to attempt to cut below knots, and to try to leave straight wood.

PROTECTION OF WOUNDS.

The chief cause of trouble after cutting back is the entry of fungus diseases after cutting back. Tar, and fungicides such as Bordeaux paste, have been used to prevent entry of disease at the cut surface. Unless, however, a shoot arises close to the cut, the wood is bound to die back to the next shoot, and disease will eventually attack the dead snag. The only perfect protection is a natural callus growth over the wound, and this can only be obtained if a shoot arises near a clean cut on a vigorous bush. The vigorous bush must be obtained by previous soil treatment and by sparing plucking.

The difficulty, of course, is to get the shoot to arise near the cut. On old hide-bound stems, particularly if cut before a dry spell, the highest new shoot generally comes away some distance below the cut, leaving the wood above the shoot to die. If, however, the shoot will not come at the cut, the cut can always be made at the shoot after a shoot has grown. The second cut is best made by going over the pruning a second time as soon as shoots have come away after the first cutting back. This of course greatly increases the labour of pruning but it is better to do a small area well, than a large area badly.

If however the snags are left for one year only, little harm is done, but tea after medium pruning should never be left unpruned, unless the snags are first removed either immediately after cutting back, or at the end of the year following the cutting back.

In the case of a cut right down to the ground, the cut is automatically made very close to the place where new shoots will arise, and therefore if the stump comes away quickly it will always start to callus. Shoots from collar-pruned bushes however are often very slow in coming, and meanwhile the exposed stump dries, bark cracks away from it, and the wood starts to die back. Disease then enters, and even though shoots arise from lower down, the life of that bush is often a short one. The higher the stump is out of the ground, the more likely it is that shoots will arise from it, but it is also more likely that they will arise below a piece of dead wood which will become diseased.

Shoots arise much less readily from roots than from stems. It is therefore not sound to fork away soil before cutting and cut through the root itself, but if half an inch of stem is left it is sufficient on an old stump. The cut will then be about at ground level where the bark will be kept moist by the soil, and after the stump has come away it will become covered by soil, which will assist the continued growth of the protective callus, by keeping it moist, while the layer of soil is itself a protection against fungus attack. Stumps cut to the ground and lightly covered with soil usually callus well, and throw good shoots also particularly in sandy soils.

Shoots however do arise more freely if the stump is exposed by forking away the soil. This forking is often overdone and then results in drying not only of the stump but of the roots also. Only an inch or so of stump should be exposed at most. In this case the cut bark is exposed to drying. It will however callus splendidly under a paste, of fresh cattle manure with a little soil, spread over the cut, particular attention being paid to the covering of the cut bark. This paste may be applied also with advantage to cuts on thick branches.

It is hardly necessary to remark that cuts should be made as smooth as possible, to give them the best chance of callusing over. Because, once upon a time, daos were used for heavy pruning, it cannot be argued that the nature of the cut is of no

importance. Kukris are still occasionally used with success for collar-pruning, but the instruments are sharp and the men skilled in their use.

For cutting to the collar or for heavy branches, a sharp saw is the best instrument, and it should leave the bark unbroken at the edges. The practice of bevelling the edges of a saw cut with a knife is a bad one. The wood, above the level to which the bark is cut, is almost certain to die and to hinder callus formation.

PREPARATION FOR CUTTING BACK.

If cutting back is to fulfil its purpose of replacing old and diseased branches by vigorous new ones, the bush must be got into vigorously growing condition before it is cut down.

No treatment, of course, can cause dead wood to throw new shoots, nor will treatment produce good shoots from branches so diseased that they ought to be cut away ; but treatment should be able to produce good shoots at least from the parts of bush which will be left after heavy pruning.

If a bush is so weak as to carry no good shoots, then to heavy prune it will only further weaken it. The cutting back of such a bush should be postponed till it is in better condition. If treatment applied with this object is found to make heavy pruning unnecessary, all the better ; but at any rate such cultivation, manuring, and sparing in plucking must be applied as will bring the bush into condition to come away well after cutting back. Neglect in these respects before the cutting, cannot be atoned for by good treatment after the bush is cut-back. It is clear that a bush cannot take advantage of raw material in the soil, if it has few leaves or none to manufacture it into plant food. A cut-back plant can only take advantage of good after-treatment when sufficient leaves have been grown out of reserves produced in the bush before it was cut down. There are, for examples, cases on record where a section has been cattle-manured and a part cut down immediately afterwards which came away

much less well than another part carrying similar tea which was cut down a year after the manure had been applied.

MANURING BEFORE CUTTING BACK.

As regards manuring 20 tons of cattle manure per acre, a year before cutting back, is an ideal preparation, and one that is usually sufficient by itself. Failing that, a mixture of artificials to suit the soil combined with green cropping may be used.

The very common method of relying on a single standing green crop to be trenched in, in alternate lines, is not a good one. The tea is too liable to suffer in vitality, even if only temporarily, from the presence of too dense a crop of green manure for so long, and the cutting of the roots by trenching also introduces another possible cause for loss of vitality. To cut down and trench at the same time is particularly objectionable, since the bush is then damaged at both ends at the same time ; but a weak bush may not recover from trenching even after a year. Nor is it desirable to bury all the manure on one side of a bush only. If high growing crops which occupy the soil for a year are preferred, then it would be better to sow the first green crop 4 years before cutting down is intended, trench in the first crop three years before cutting back, sow another crop on the trenched lines, and trench in the second crop two years before cutting back. For the year before cutting back a complete mixture may be used. Unless however there is a definite mechanical obstruction in the soil which is hindering growth, deep trenching is not recommended for tea to be cut back, although shallow trenches may be used as convenient for burying green crops.

It is of course impossible to lay down rules for the amount of manuring necessary before cutting down. If after one year's treatment the condition of the tea still appears too poor, then treatment should be continued.

PLUCKING AND PRUNING BEFORE CUTTING BACK.

If the frame is to be cut away there is no object in spending money and time on expensive pruning. To leave the bush unpruned however may be to expose it to such a strain as will

weaken it. A good system in general is merely to cut across without any cleaning out at all. The wood left, also, may be rather longer than is usual on ordinary top-pruned tea. A good crop will then be obtained, without undue exhaustion of the bush, if it is in good health.

In the case of a bush which is to be cut down because it is weak, or becoming weak, it should naturally not be exhausted by any attempt to get a large crop before cutting down. No rules, of course, can be suggested, but plucking should be lighter according as the bush is weaker, and in extreme cases it is advisable to leave weak bushes unplucked altogether.

SOIL TREATMENT AFTER CUTTING BACK.

When tea prices are good, it pays to manure any tea every year. Whatever prices may be, however, it is essential that a cut-back bush should be fed, while it is rebuilding its frame. No rules applicable to all soils can be given, but manuring must vary according to the soil. Complete mixtures accompanied by green manuring are required. While "pruning mixtures" should nearly always provide potash and phosphoric acid, it is unsound to rely on these only. Nitrogen also is necessary to produce good stems and leaves to feed them.

Cultivation also must not be neglected. This is an important matter when considering the advisability of cutting back. While bushes which provide good cover may keep fit on three or four rounds of light hoeing, such treatment on a cut-back area may ruin the tea by letting it go under jungle.

One or two rounds of forking around the collar will be necessary, while if light hoeing is relied upon to keep down jungle when it is growing vigorously, a hoe as often as every three weeks may be advisable until the bush is big enough to provide cover.

If increased expenditure on cultivation and manuring cannot be afforded, then cutting back should be postponed until it can.

Collar-pruned areas on suitable land however are particularly suitable for buffalo-cultivators.

PLUCKING AFTER CUTTING BACK.

Expenditure on cultivation and manuring may be reduced if cut-back bushes are allowed to grow unplucked, or plucked very lightly until they provide sufficient cover to keep down jungle. The crop lost from cut-back tea by plucking lightly, or even not at all, cannot be very considerable, while no other treatment can have such good effects on the bush.

Collar-pruned tea (if very vigorous) may be plucked to 27 inches, or sometimes even 24 inches, from the ground, without much harm if it is to be pruned again in the following year. Thirty inches or even 36 inches is often much better on weak tea, in the latter case plucking being only sufficient to hold back over-vigorous shoots.

It is uncommon to find collar-pruned bushes over-plucked, because to do so would mean plucking inconveniently near the ground, but it is very often the case that the only reason why medium-pruned tea is unsuccessful is that it was over-plucked after cutting back. Much of course depends upon the vigour of the bush, but in our opinion a cut-back bush of good jat very rarely should be plucked to leave less than 12 inches of new growth above the pruning cut (which on a bush pruned to 18 inches from the ground means plucking at 30 inches from the ground), while plucking in no case should be nearer to the ground than 27 inches.

PRUNING AFTER CUTTING BACK.

After cutting back, pruning has of course to be directed to the building of a strong frame of reasonably wide spread, but the chief consideration must be the avoidance of diseased wood in the bush.

The year after cutting back is the time when good pruning is of the greatest importance.

Whether the tea was medium pruned, or collar pruned with Kickers left, new shoots will have arisen in many cases some distance below the cuts and hence will have dead snags above them.

It is at this stage that it pays, after cutting at the height ordered, to get at the bush with knives and small saws to cut out every bit of dead or diseased wood flush with a sound shoot.

This pruning is far more important than the original cutting back, for nothing but sound wood should remain after it. The old wood should in every case be left protected by a shoot growing from its top, and the new one-year wood should also as far as possible be cut to an eye. Such a bush very easily can be kept free from dead wood throughout its future history.

Because it is necessary to clean up a bush as soon as possible after cutting back, tea should never be left unpruned the year after cutting back, unless either the original cut was flush with the ground leaving nothing, or the original heavy pruning was gone over again to remove snags after shoots had come away.

When the bush has been thoroughly cleaned up and has had two years' of light plucking, it should be vigorous enough to be left unpruned without fear, with the double object of getting a good crop and of leaving leaves to feed up a strong low frame. If left unpruned, the bush must be cleaned up again very carefully at the next pruning. For example the following rotation of pruning would be good one, though it is by no means suggested as a standard to suit all cases.

First Year. Cut-back.

Second Year. Pruned leaving 4 inches to 10 inches new wood (according to height of original cut), and all dead and diseased wood removed.

If less than 4 inches new wood, thick after generous growth, is left, the new shoot is very likely to arise from the base of the new wood leaving a lot to be cut out at the next pruning.

On low cut tea more wood will naturally be left. Opinions on how much wood should be left after collar-pruning vary between 5 inches and 12 inches above the collar. The lower the cut, the wider will be the spread near

the ground, while the higher the cut the greater will be the immediate crop, the less die back there will be, and such dead wood as occurs is more easily cut out in the following year.

In our opinion about 8 inches is generally most satisfactory, but it may be lower on thin wood which has grown nearly perpendicularly; and higher on wood which is very thick and well inclined outwards.

Third Year. Unpruned, if bushes are thoroughly fit.

Fourth Year. Pruned 3 inches to 6 inches above last pruning cut, and all snags carefully cut out flush with a branch.

Here, again, very short wood should not be left, or new shoots may arise from the junction of the 2nd-year wood and the 3rd-year branch, forming a knot.

Fifth Year. Pruned as appears to suit bush best.

Sixth Year. Unpruned.

METEOROLOGICAL OBSERVATIONS IN THE DOOARS,

1925.

BY C. R. HARLER.

PLANT DISEASE AND THE WEATHER.

Of recent years the study of plant disease has had an increasing tendency to take into account not only the pest or blight itself but also the host. It is becoming more and more evident that strong plants are able to throw off disease attack and that an attack by an insect or fungus which succeeds in killing or seriously incapacitating a plant may be taken as a sign of weakness in the plant. Some seasons may be more favourable to the development of a certain disease than others and during these seasons the plant will suffer more, especially if weather favourable to the disease is unfavourable to the host.

In the cultivation of tea as in other branches of agriculture it is noticed that diseases suddenly appear, do more or less damage and then disappear. The disease is present always but suddenly becomes epidemic and then some factor changes, conditions become unfavourable to the disease and its ravages are reduced to negligible proportions.

A few years ago Thread blight became serious in tea gardens in Assam but now it is rare. In 1922 and 1923, Black rot, a species of *Corticium*, attacked the stems of tea bushes. Spraying with lime-sulphur was resorted to and the disease ceased to be a menace, although it is probable that a change in some factor, probably one beyond control, had more to do with the lifting of the attack than had the spraying. During the seasons 1924 and 1925 another species of *corticium*, as yet unnamed, put in an appearance although as soon as it became epidemic planters remembered having observed it in a sporadic form for many years.

Diseases come and go naturally but spraying does much to control them. It has been observed at Tocklai that although spraying lessens Red spider the actual attack ceases at the same time on both sprayed and unsprayed areas. It is important to remember however that the coffee leaf disease (*Hemelia vastatrix*) of Ceylon came and remained to blot out the coffee industry in the Island in a decade or so.

Many gardens are now suffering badly from root disease, especially *Sphaerostilbe repens*. This may be partly accounted for by the fact that the years 1920 and 1921 following immediately on the slump were years of reduced cultivation and a general falling off all round in the quality of garden work. The seasons 1922, 1923 and 1924 opened with severe droughts. The result of all these factors was a bush so weakened that it easily succumbed to fungus diseases ever present in the soil. The soil had not suddenly become "sick" but the bush had gradually weakened. A strong bush can often throw off disease and for this reason systematic manuring, good cultivation and careful pruning to a great extent obviate the necessity of the use of fungicides and insecticides.

It is difficult to trace exactly which climatic factors increase or decrease disease attack since so little is known of the environment influencing disease. It is known that temperatures much above 75°F are fatal to Blister blight (*Exobasidium vexans*) and the coming and going of this blight is thus, in a sense, understood but little is known of the general conditions favouring any diseases and further knowledge will be available only after many accurate field observations. Results obtained in the laboratory do not always hold in the field where conditions are much more complicated. In the laboratory every factor is under control.

In studying weather conditions in connection with plant disease, climatic extremes tell us more than means, for life is influenced by extreme weather conditions and not by average temperatures and humidities. Thus the

average temperature of Darjeeling is only 2°F above that of London but the vegetation of the two places is very different. Darjeeling is subject to a different range of temperature from that experienced in London and palm and pine are able to grow there side by side.

An average value suppresses much and the average of a particular season gives no indication as to the peculiarities of that season. The annual average rainfall gives no idea as to the variation from year to year. In tropical countries it may be said that the annual rainfall varies much more than in temperate regions. At Tocklai with an average of 81 inches of rain the past eight years have shown totals as low as 66 and as high as 101 inches. At Sylee in the Dooars with an average of 164 inches a similar period has shown variations between 113 and 204 inches. This variability of rainfall may be measured by expressing the difference between the greatest and least annual rainfall as a percentage of the average. Thus at Tocklai the variability of rainfall is

$$\left(\frac{\text{Max.} - \text{Min.}}{\text{Average}} \right) \times 100 = \left(\frac{101 - 66}{81} \right) \times 100 = 43\%$$

At Sylee where greater variation is experienced the value is 55 per cent. In the Terai the value rises to 62 per cent. and in parts of Behar to 108 per cent. The variation in crop then, due to variation in climate, will be greater generally in the Dooars than in Assam.

The curves opposite show the crop in pounds made tea per acre of plucking area from the year 1896 to 1924 in the Jalpaiguri district (Dooars) and in the Brahmaputra Valley. The values are taken from Government returns. The curves are reproduced with the object of estimating roughly how much of the crop variation is due to climatic changes and how much due to other causes. In the Dooars the main cause of annual fluctuation of crop, other than the weather, is the severity or otherwise of mosquito attack.

It will be observed first of all that from 1900 to 1920 there was, in general, a steady crop increase due partly to improved methods and manuring, partly to coarser plucking and partly to the maturing of large areas of tea. The Brahmaputra Valley with a much lower crop than the Dooars gradually increased in outturn till both areas were about the same from 1915 to 1919. At the beginning of this period the tea in North-East India was in better fettle than it had ever been before. The years 1920 and 1921 following on the post-war slump were years of fine plucking and heavy pruning. During the next four years plucking became somewhat coarser as the market became stable but it is doubtful, even with the free plucking employed during the war years, whether the tea in its present condition is capable of touching the same output as during 1915-1919. Towards the end of the War period the rate of manuring fell off on most gardens and the big crops in these years were undoubtedly taken at the expense of the plants' reserves. The better treatment accorded to the bushes from 1922 onwards has done much to repair the earlier damage.

A detailed examination of the curve yields much information. In the Brahmaputra Valley the tea mosquito (*Helopeltis theivora*) does no appreciable damage and crop increases or decreases apart from the steady general increase is due mainly to seasonal variations. In 1898 and 1900 the Dooars crop fell whilst that in Assam rose. From 1902 to 1906 there was a continuous crop rise in Assam but the rise in the Dooars during this period was broken in 1905 when the crop was the same as in the previous year. In 1908 there was a slight drop in Assam and a much greater one in the Dooars. The same thing occurred again in 1910. Whilst allowing for the depredations of mosquito it must be realised that when the crop falls in both districts at the same time then the chances are that the cause is similar. In Assam the cause is generally assumed to be the weather and indeed crop depression in the Assam Valley can be closely correlated with this factor although the ultimate cause may be some unrecorded disease. In the Dooars there is a tendency

not to allow the climatic factor its full influence in controlling crop and to attribute a much greater percentage of the crop variation to mosquito attack than is justifiable.

The years 1910, 1911, 1912 were poor ones in the Dooars compared with the big year of 1909. The crop rose sharply in 1912 in Assam but not in the Dooars although in spite of this the years 1910-12 were certainly not ones of general decrease.

In 1913 the Dooars went well ahead again only to fall back in 1914 whilst Assam showed an increase in the same year. From 1915 to 1919 the crop averaged over 9 maunds an acre and only in 1918 did the Dooars show an appreciable drop during this period. Since 1919 the issue has been confused on account of crop control.

The curve relates of course to the Dooars as a whole and variations in the crop of local areas are thus masked. The year 1918 is reckoned in some districts to have been one of the worst mosquito years known but although the crop certainly shows a fall it is still much above 1909, a record year at that period, and not much in default of the 1913 crop, another record year.

Some years have been admittedly bad with mosquito but others like the present season (1925) have been fairly free although the crop has been in default.

The figures for 1925 show the Dooars crop to be about 590 lbs. and the Assam crop about 650 lbs. per acre. Thus the average crop is now back to what it was about a decade ago although the plucking nowadays is finer than it was then.

THE 1925 SEASON IN THE DOOARS.

The 1925 season started well, for the bushes were not hard pushed by the drought. The table below gives the dates of the last and first satisfactory falls, i.e., falls of about an inch or more, over the past few years. During the early months of the year a fall of much less than an inch seems to aggravate the effect of the drought for the

The Drought
Period.

soil is only penetrated to a depth of two or three inches and the mulch is destroyed.

Table showing Drought Period at Sylee.

Cold Weather.				Last Rainfall.		First Rainfall.	
1916-17	...	...	...	October	17th	March	21st
1917-18	...	...	...	"	8th	"	28th
1918-19	..	...	...	"	13th	"	4th
1919-20	...	...	...	"	8th	"	23rd
1920-21	...	...	...	"	28th	"	9th
1921-22	...	...	...	"	10th	"	9th
1922-23	...	...	...	November	4th	"	28th
1923-24	...	...	...	"	13th	April	28th
1924-25	...	...	...	"	7th	"	6th

In October 1924, rainfall amounting to 20.42 inches was registered against an average for this month of 7.49 inches. In November of the same year 3.50 inches fell against an average of 0.98 inches. In December, January, February and March one or two showers were registered amounting to 0.20 inches, a negligible quantity.

At the beginning of April the bushes were looking healthy with the spring flush but the relative humidity was down in the neighbourhood of 40 per cent. and had not rain come when it did the effect of the drought would have soon been apparent. On the night of April 5th the rain came quite unexpectedly, and from that date till the end of October precipitation was continuous and on 20 days only was there no rain.

Although the first falls during April were intensely local the relative humidity rose from about 50 per cent. to 80 per cent. with the first rain, proportionately decreasing the loss of soil moisture by evaporation and transpiration from the leaves. Although some gardens did not get rain till the middle of April they benefited from the damp air flow which came at the beginning of the month.

In April 118 hours of bright sunshine were recorded, mostly in the first 20 days.

There was no break between the early rains and the Monsoon, and in May 37.50 inches were registered against an average of 11.08 inches for this month.

Hail was rare. During May there were 101 hours of bright sunshine, evenly distributed.

The advance of the Monsoon in June was anything but spectacular for its advent was marked only by a sharp rise in the vapour pressure from 0.80 to 0.90 inches and an increase in minimum temperatures from about 75° to 79°F. In June, 124 hours of bright sunshine were registered and the distribution was good.

In July rainfall was in defect of the average but a steady drizzle persisted during the second half of the month and the sunshine only amounted to 94 hours, more than 60 of which were recorded in the first fortnight.

August was the wettest month of the season and 41.04 inches fell against an average of 28.01 inches. The total bright sunshine amounted to 96 hours but this was unevenly distributed and in the middle of the month rain was incessant. During the first six days of the month, 36 hours of sunshine was registered but during the next 14 days only 18 hours were registered.

In September 32.84 inches of rain fell and during the third week of the month 14 inches were recorded. Up to the 22nd of September Monsoon condition prevailed but two days later the whole weather aspect had changed and the atmosphere became dryer. Although two big falls were registered after this date the air still remained dry and the vapour pressure fell from about 0.92 to 0.84 inches of mercury and the relative humidity from 90 to 80 per cent. The total sunshine for September was 86 hours, again badly distributed.

The sharp drop in humidity together with low night temperatures made for an early close to the season. The Monsoon was not a strong one for the steady south-west breeze was never firmly established for any length of time and much of the rain came from the north by reflection from the hills.

Below is given the monthly rainfall for Sylee and the average values taken over the past ten years.

	Jan.	Feb.	Mar.	Apl.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Average (10 yrs.)	0.47	0.74	1.12	3.99	11.09	33.43	44.56	28.21	28.07	7.49	0.98	0.19
1925	0.04	0.12	0.14	15.87	21.63	28.55	33.12	41.04	32.84	9.10	1.05	nil

The average total is 164.48 inches and the total for 1925 is 181.50 inches.

It is of interest to note the difference between the sunshine in the Dooars and at Tocklai. The Table below shows the values during the 1925 season over the months April to September during which period Dooars records are available.

Table showing average daily Sunshine in hours during 1925.

	April.	May.	June	July.	August.	September
Dooars ...	3.9	3.3	4.1	3.0	3.1	2.9
Tocklai ...	3.5	3.3	5.2	5.1	4.4	3.9

The continuous rain right from the arrival of the Chota Barsat in April has been considered by some Green Crops planters to be largely responsible for failure of most green crops throughout the Dooars during the season under discussion.

When putting out green crops it is preferable to sow a small acreage daily over a month or six weeks rather than the whole area in a few days. The former arrangement not only ensures that some of the crop shall be sown at the most favourable period, but simplifies the hoeing in of the crop.

Pests and Blights. During April and May, Red spider was bad. It advanced in two waves and the bushes which escaped the first and less severe attack in April succumbed to the second in May. In spite of the heavy rain

this pest persisted. Blocks which had been sprayed with lime-sulphur, liberally sulphured or carefully cleaned out at pruning remained comparatively free from attack. After an attack of Red spider the bushes should be lightly plucked.

In June green fly came. The gardens on sandy soils seemed to suffer most. It is interesting to notice that in August a second green fly attack was reported and although the bushes had the "tucked up" appearance associated with the incidence of this pest, practically no green fly was to be found.

Towards the middle of June, mosquito attack began over large areas but after a week of fine weather the bushes got away again. The attack as a matter of fact showed up during the lull between the May and July flushes. From June onwards the attack was always noticeable, sometimes markedly, just after plucking, and at other times, with a flush on the bush not so easily.

In August mosquito descended in full force on some areas and the bushes took on the dark, shiny appearance peculiar to this form of pest attack. Brown blight on the stems, Grey blight, Corticium and Red rust were by this time present on the majority of attacked bushes but some were observed to be free from these blights and these bushes generally flushed again. The season ended quickly before the bushes had time to recover from mosquito.

THE SOIL CONDITION.

Just before the first rain the soil moisture at Sylee (a Mal Sand) and Nedeem (Red Bank) showed as follows :—

			Sylee.	Nedeem.
	at 6 ins.	...	2.7%	21.0%
18"	" 2 ft.	...	5.7%	23.1%
30"	" 3 ft.	...	10.0%	23.3%

In spite of the fact that the Sylee soil was so dry the bushes were flushing vigorously. With rain the soil moisture rose to about 15 per cent. in Sylee and 25 per cent. in Nedeem. These values are about the optimum for both soils and were roughly maintained throughout the season.

It required about three weeks of steady rain-amounting to over 10 inches before the sub-soil became thoroughly wet and reached the condition which was maintained during the Monsoon.

The table showing moisture values illustrates :—

Date.	April 5th.	April 13th.	April 20th.	April 27th.	May 4th.
Total Rainfall to date ...	<i>nil</i>	2.71"	5.22"	8.82"	16.97"
Sylee No. 10, top soil ...	3.2%	13.5%	12.5%	14.8%	14.4%
" " 10, at 2 ft. ...	5.5%	9.6%	13.9%	16.7%	16.5%
" " 10, " 3 ft. ...	7.0%	7.0%	12.7%	16.1%	15.9%

Date.	April 5th.	April 16th.	April 23rd.	April 30th.	May 7th.
Total Rainfall to date ...	<i>nil</i>	5.10"	7.36"	15.87"	18.71"
Nedeem No. 8, top soil ...	21.0%	22.3%	25.3%	25.9%	25.5%
" " 8, at 2 ft. ...	23.1%	22.5%	26.0%	29.0%	29.1%
" " 8, " 3 ft. ...	23.3%	25.5%	23.0%	30.0%	29.0%

A weekly estimation of the soil nitrates on both soils showed that after the rains had set in in April the value fell from about 5 parts to about 0.05 parts nitrates per million parts of soil, and remained at that figure till the end of September.

THE WEATHER CHART FOR 1925.

The accompanying chart shows the rainfall, the crop curves for Sylee and Nedeem and the maximum and minimum temperatures recorded on the bungalow verandah at Sylee. The latter figures are not comparable with temperatures taken under the standard conditions laid down by the Meteorological Department of India* which require that the maximum and minimum thermometers shall be kept in a white, louvred box of special design placed in the open, three feet above the ground.

*Instructions to Observers of the Indian Meteorological Department.

Temperatures taken under such conditions are generally lower than those shown by bungalow readings.

The top soil moistures of Sylee No. 10 and Nedeem No. 5 are shown over a period of six months during which time very little change is noted. The Nedeem soil is a Red Bank clay with a greater water holding capacity than the Mal sand at Sylee.

The crop curves show that the tea came away sooner at Sylee than at Nedeem as might be expected. A sand is usually earlier than a clay except in the case of a severe drought. After Nedeem started to yield the form of its crop curve was much the same as that of Sylee.

The vapour pressures curve is shown for six months. The values are obtained from the readings of the wet and dry bulb thermometers taken at 8 A.M. and the actual vapour pressure figures are calculated from tables.*

Vapour pressure or humidity is the controlling factor in deciding the tea crop. The indigenous tea bush is constructed to live in a hot, humid climate and its leaves are designed so that they are able to transpire freely. The leaves of China bushes are slightly differently made from those of Assam and Burma bushes and the China jat is able to withstand the drought and cold better than the other varieties. At Ranchi, where dry weather conditions are extreme, only China bushes will grow successfully. In Japan where the atmosphere is quite humid but the cold weather severe, China bushes are again the only successful ones. In Chittagong, South Sylhet and the Terai, all three districts liable to prolonged droughts, indigenous bushes are noticeably "thinner" than in Assam where low humidity is seldom a matter for worry.

Humidity also has a great influence on the quality of the tea made. Since high humidity makes for good crops it follows that when the crop is heaviest the possibilities of good withering will be reduced, so that a rush of leaf generally coincides

* Tables for the Reduction of Meteorological Observation in India by Simpson & Walker, Government of India Meteorological Department.

with a fall in quality of the tea for reasons not only attributable to factory limitations. In most Dooars gardens there are hot air withering lofts which give a certain amount of control over the wither but the greatest use is seldom made of such lofts. In Assam the number of days on which a natural wither is possible is greater than in the Dooars but some scheme of control is still necessary although at present lofts are rarely used.

In the fermenting room a high humidity is necessary in order that good colours shall be obtained. It is noticed that the best colours are obtained on wet days and that better colours are obtained in the morning than in the afternoon when the air is dryer.

IMPORTANT POINTS IN TEA MANUFACTURE.

PART II.

BY

P. H. CARPENTER AND C. R. HARLER.

Fermentation.

The fermenting room should be cool and damp. The temperature of the room by no means controls that of the ferment, but it undoubtedly has a large influence on it, and should be kept at 82°F. or lower if possible. This temperature represents a practical maximum in the plains during the hot weather.

Light, so far as can be seen, has but little influence on the course of fermentation but it has become customary to keep fermenting rooms dark. This usually ensures a lower temperature in the room. It is not considered desirable that the fermenting room should be so dark as to make supervision of work difficult. Direct sunlight or direct reflection from the overhead sky is to be avoided.

The floor of the fermenting room is best made of good cement. A lime cement, being alkaline, should be avoided for alkalinity gives dark colours. Although experiments have been made in order to test which is better, glass or cement beds, and the results generally have shown no practical difference between the teas fermented on either, still the general opinion is that it is easier to make good tea on cement than on glass.

The fermenting floor can be kept clean by washing with cold water and no accumulation of slime should be allowed. Particular care should be taken with the cleaning of the floor and as soon as any unpleasant or unrecognised odour is noticed in the room, the floor should be thoroughly washed and scrubbed with cold water and if this does not affect the removal of the smell then a dilute solution of permanganate of potash should

be used. On no account should lime water or washing soda be used for this purpose since these solutions, if not completely removed by the final washings with water, will produce bad colours.

The floor should contain no corners, crevices, nor cracks capable of harbouring old leaves or tea juice. In order to facilitate the keeping clean of the floor there should be no raised nor sunk parts as beds for the leaf. Pillars in the fermenting floor should be avoided if possible since here again are angles where harmful bacteria can accumulate. A distinct camber on the floor is an advantage both as an aid to washing and also since it obviates the necessity of a definite channel to carry off any drip-water used for cooling and humidifying purposes.

The use of iron shovels in the fermenting room is to be discouraged, not that their use will appreciably alter the value of the tea but this is one of the many small points which together go to make up a measurable difference in quality.

The atmosphere in the fermenting room should be as humid as possible. The amount of moisture in the atmosphere or the degree of humidity is measured by the wet and dry bulb thermometers. These two thermometers are identical in structure except that one (the wet bulb) has the bulb surrounded by a piece of muslin kept wet by means of a wick coming from a small bottle of water. As the water on the muslin evaporates so the wet bulb is cooled. The dry bulb thermometer registers the air temperature. It will be seen that the dryer the atmosphere the quicker will the muslin round the wet bulb dry and, in consequence, the lower will be the temperature registered by this bulb. The difference then between the wet and the dry bulb will be a measure of the drying power of the air and this is actually a measure of the moisture in the air. If the difference between the two bulbs is *nil*, then the atmosphere is saturated. In this case no drying of the muslin has taken place and the relative humidity is 100 per cent. A difference of 1°F. between the two bulbs represents a relative humidity of about 95 per cent. working at the average fermenting room temperature.

In the fermenting room a difference of not more than 1°F. between the wet and dry bulb should be aimed at although this degree of humidity is difficult to obtain. With a fermenting room placed on the north side of the factory, fitted with a good double ceiling and hung with wet cloths both round the perforated walls and as baffles, a high degree of humidity is possible.

Some factories have installed humidifiers similar to those used in Cotton Mills. These humidifiers force water under high pressure through a fine jet and the result is a cloud of water vapour. A cheap, makeshift humidifier may be constructed as follows. The lance and nozzle of an ordinary Knapsack sprayer is placed downwards in the centre of a cylinder of metal about 10 inches in diameter and 18 inches long. Water at about 100 lbs. pressure is forced through the nozzle and the result is a very fair imitation of the spray produced by a humidifier. Some of the spray collects as drops which may be caught by a cone placed below the cylinder and carried off in a pipe. A little adjustment of this simple apparatus to suit local requirements will produce a machine capable of raising the humidity of the fermenting room to 100 per cent. Head space of about 15 feet is necessary otherwise the area over which the machine produces an effect is much reduced.

The influence of humidifiers on colours is discussed later but it must be mentioned that as the air becomes loaded with water vapour so the temperature falls. How far the good colours are due to high humidity and how far to low temperatures has not yet been estimated.

The thickness of spreading of the fermenting leaf and the time of fermentation are factors which should be considered together. To a large extent the fermentation process may be regarded as an oxidation process which is hastened both by temperature and also by the amount of oxygen (*i.e.* air) available.

As the fermentation proceeds, briskness or pungency gives way to flatness and at the same time strength is gathered. We

are thus faced with the problem of staying the loss of briskness or pungency whilst the tea has time to take on strength. This may, in a way, be achieved by thickening the spreading which in effect reduces the air supply and slows up certain chemical reactions connected with loss of briskness. If the spreading is thicker than about 5 inches then there is a danger that the air supply will be so reduced and the chemical reactions proceed so slowly that the tea remains green. On the other hand when the reactions do proceed there is a danger with thick spreading that the heat developed will not be able to escape. The result is a rise in temperature and a consequent hastening of the chemical reactions. The problem is thus a complicated one.

One way out of the difficulty is to spread thinly—about $2\frac{1}{2}$ inches—and to put wet cloths over the ferment. The air supply is thereby restricted and at the same time the leaf does not get hot. At the end of the season when lower air temperatures are experienced the time of fermentation must be lengthened or the spreading thickened, or both. As an alternative the air supply may be increased, *i.e.*, the spreading may be thinner, provided the atmosphere of the fermenting room is humid.

The temperature of the fermenting leaf should be as near 82°F. (or lower) as possible when it is first put on the fermenting beds. If the leaf as it comes from the roller is put through an efficient ball breaker installed in a cool place, it will certainly cool to a low enough temperature. During fermentation the temperature rises to a maximum at which it remains for some time and then falls. The maximum temperature should not be above 86°F.

The time of fermentation must depend on the chemical state of the leaf when it leaves the withering racks. Quite apart from this, however, different gardens seem to produce leaf requiring different types of fermentation and experiments are needed on each individual garden. All experiments however must be carried out with forethought and care and only one factor should be varied in each experiment. Results must be interpreted with caution and each experiment must be pushed to a conclu-

sion. A pointed example may be quoted. At one factory the teas produced were weak and the suggestion was made to lengthen the time of fermentation. Three experiments were carried out with the leaf fermenting for 3, $3\frac{1}{2}$, and 4 hours. The 3-hour tea was brisk and weak and valued at Re. 1/- (nominal). The $3\frac{1}{2}$ -hour tea was less brisk but stronger and valued at 14 annas whilst the 4-hour tea was still less brisk, but notably strong and valued at Re. 1/0/6. The second tea was mediocre with no stand out briskness or strength and thus the price was not intermediate between the other two but below them. If a single experiment only had been tried and the fermentation increased by half an hour the wrong conclusion might have been drawn.

The colour of the infused leaf is important. The green colour often obtained may be due to an insufficient wither, not enough air in the fermenting leaf or a too short fermentation. Dark green colours are often the result of a dry breeze blowing on the leaf. Uneven colours result from insufficient ball breaking after the rolling process. A bright green infusion usually goes with a brisk tea and indicates underfermentation. Such teas when over-brisk are often called "raw" or "green." A dark green infusion goes with a flat tea and often denotes underwithering accompanied by over-fermentation.

Bright colours are obtained from fully withered leaf if the fermentation is a short one but it is easier to obtain good colours from leaf withered on the light side. Thin spreading, provided the atmosphere is humid and no drying of the leaf takes place, gives bright colours, but it may by reason of the plentiful air supply, push certain chemical changes to a conclusion before others have had time to develop sufficiently and the resulting tea may be soft.

Good results have been obtained by spreading thickly (to 4 inches) and turning the fermenting leaf each half hour. The best results have been obtained from leaf thinly spread in a cold, humid atmosphere.

The best colours are generally made in the morning when the temperature is low and the atmosphere humid. Poorer colours are made in the afternoon as the atmosphere gets dryer. In some factories all tea is manufactured at night for it is considered that the slacking off in efficiency which must arise with night work is more than compensated for by the lower temperatures and higher humidities pertaining at night.

If the temperature of the leaf is kept low and the atmosphere humid then the rate of oxidation going on during fermentation may be said to be proportional, within limits, to the air supply. This means that with the conditions regarding temperature and humidity ideal, a thin spread (good air supply) combined with a short fermentation should give the same results as a thicker spread with a longer fermentation.

This has been observed in the factory many times and the teas produced under the following conditions—

2½ inches spread	3¾ hours' fermentation.
3½ inches spread	4½ hours' fermentation.
5 inches spread	6 hours' fermentation.

were identical so far as the taster's report was concerned. No very definite figures can be given concerning the best fermentation conditions because so much depends on the degree of the wither. With a normal good wither, a cold rolling room (82°F.), and leaf in the fermenting room at 82°F., a fair average time of fermentation is 3½ hours if the leaf is spread at 2½ inches. At 73°F. it has been found that the time must be increased to 4½—4¾ hours and for intermediate temperatures the increase should be in proportion.

FIRING.

From the chemical point of view firing merely means the cessation of chemical action in the leaf. The rate of fermentation increases with temperature so that unless the leaf meets a certain degree of heat on entering the dryer the fermentation is merely carried on at an increased rate and the tea may be

overfermented and lose briskness unless the necessary allowance is made in the time the leaf remains on the fermenting floor.

The temperature of the exhaust air of a pressure dryer, *i.e.*, the air which meets the leaf when it first enters the dryer, should be about 120°F. below the top tray. Theoretically the best temperature is 150°F. but with the ordinary dryer such an exhaust temperature would necessitate too high an initial temperature.

The first fire should be at least 12 annas otherwise the second fire must be carried out at a high temperature and the tea is liable to lose quality.

The firing temperature should be kept as low as 170°F. on forced draft machines. If the firing temperature is too low—below 140°F.—the tea will not keep, for the enzymes are not destroyed and fermentation continues. As the temperature of firing is increased so the tendency to produce poorer teas is increased. The higher the firing the less briskness and the less strength will be obtained in the final teas. High firing destroys the colour of tip.

In many factories firing is carried on at high temperature in order to cope with the leaf. In others it is often stated that a dryer will not function unless the initial temperature is at some figure far beyond the safety mark. In these latter cases the trouble generally lies with the fan which is too slow running. The capacity of a dryer is the product of the rate of air flow and the temperature of the air. It follows then that the capacity may be increased by speeding up the fan and leaving the temperature at its original figure. In several factories the fans are run at speeds somewhat in excess of the scheduled number of revolutions and good has always resulted from such increases.

A series of experiments were carried out on a Down Draft Dryer in order to investigate the temperature at which tea was high fired. This particular type of machine was used because

of the ease of control but the temperatures apply to any form of dryer.

Thus—

Tea fired to 16 annas at 170°F.	—	not high fired
Tea fired to 16 annas at 170°F then left		
at 170°F. for 15 mins.	—	not high fired .
Tea fired to 16 annas at 210°F.	—	not high fired
Tea fired to 16 annas at 210°F. then		
left at 210°F. for 10 mins.	—	high fired
Tea fired to 16 annas at 240°F.	—	high fired
Tea fired at 170° and temp. raised to		
240°F. by which time tea had		
dried to 14 annas	—	not high fired
Finished at 170°F.		

The conclusion is that tea cannot be high fired at 170°F. but that temperatures over 200°F. become dangerous if the tea remains for long at such temperatures. True, Empire machines with initial temperatures as high as 260°F. turn out tea which is not high fired but it must be remembered that the leaf on the bottom tray only is submitted to this temperature. Firing under such condition causes a loss of briskness and strength in the finished tea.

When leaf is fed into an empty dryer the first tea discharged is liable to be high fired, if the dryer is heated to much more than 200°F. In order to obviate this the side doors of the dryer should be left ajar till the first leaf is near the bottom trays.

Automatic temperature recorders are useful on drying machines. Although no very definite firing temperature can be given if tea is to be consistently turned out at 12 annas during the day a variation of 10°F. should cope with any variation in the moisture content of the leaf during the day's manufacture.

Tea when it is packed should contain 5 to 6 per cent. moisture. If it contains more it is liable to "go off" before it gets Home and if less, post-fermentation is restricted and the tea will not mellow and it

"Gaping"
of Tea.

also loses pungency. When tea comes from the second dryer it contains 2-3 per cent. moisture but during sorting more is picked up, for tea is very hygroscopic, and the moisture increases to 7 or 8 per cent. In cases where much picking over for stalk is done the moisture figure may rise to 10-11 per cent. In several cases where complaints have been received that the tea does not keep well, examination has shown the moisture content to be between 7 and 8 per cent.

It is very difficult to tell by feel or smell whether tea contains the right amount of moisture for packing. Some factories have installed a chemical balance and a small steam oven and thus the moisture content of each bin is estimated before the tea is packed. The process of moisture determination is a simple one and the apparatus costs less than Rs. 200.

The unnecessary heating of tea causes loss in the quality of the liquor so that gaping should only be employed when it is necessary and even then it should be carried out at as low a temperature as possible. A temperature of 180°F. is sufficiently high.

SORTING.

The sorting of tea is so largely dependent upon market conditions that it is not proposed to deal with it here. There is, however, one point to which attention might be called. The "greying" of tea is brought about during sorting and cutting of the dry leaf and consists in polishing the surface of the tea. Any machine therefore that causes a rubbing of the surface of the leaf tends to produce greyness. Machines running at high speed by increasing the rubbing effect tend to increase the amount of greyness. In sorting therefore the type of machine used should be one that, so far as is practicable, does away with the rubbing of the leaf. The circular sifters running slowly consequently tend to grey the tea less than if they are speeded up but in any case they cause the rubbing action to take place. Other machines such as rotary sieves running at much higher speeds also give greyness to the tea. Machines which produce a hopping rather than sliding action on the sieves tend to grey

the tea less. Machines depending on an air-blast such as the deflector type of machine are the least liable to grey the teas. One cause for the greying of tea is the speed at which the cutters or breakers are run. A fast run machine will tend to grey the teas much more than one run slower, and consequently such machines should be run at the slowest speed that is compatible with efficiency. One often sees such machines run at too high a speed in order to get through the amount of work whereas what is really required is another machine so that the two machines may both work at proper speeds.

During the sorting tip is very easily destroyed, consequently to obtain a tippy finished tea it is necessary that the fine mal should be subjected to the very least possible amount of sorting and cutting.
